COORDINATION

GATE 2005

1. $[Co(NH_3)_4(H_2O)Cl]Br_2$ and $[Co(NH_3)_4Br_2]Cl \cdot 2H_2O$ on ionization produce Br^- and Cl^- ions respectively. Hence, they are examples of ionization isomerism.

   Correct option is (a)

2. In the trigonal bipyramidal crystal field, he energy order of d-orbital is

   $$\xleftarrow[\text{Energy order}]{dz^2 > dxy = dx^2y^2 > dxz = dy^2}$$

   the highest energy d-orbital is dz^2.

   Correct option is (d)

3. $K_3[CoF_6] \rightarrow Co = 3d^7\ 4s^2$

   $Co^{3+} = 3d^6$

   For d^6 high spin electronic configuration is $t_{2g}^4\ eg^2$

   $CFSE = [-0.4\ p = 0.6\ q]\Delta_0 = [-0.4 \times 4 + 0.6 \times 2]\Delta_0 = [-1.6 + 1.2]\Delta_0$

   $CFSE = -0.4\Delta_0$

   In this case, no pairing energy is included because no pairing of electrons is caused by he ligand.

   Correct option is (a)

4. Four coordinated complexs are mor labile than six-coordinated complex due to more space for attack of nucleophile. Hence, rate of exchange in $[Ni(CN)_4]^{2-}$ is highest.

   In octahedral complexes rate of exchange is decided by change in CFSE on going from octahedral to five coordinated intermediate octahedral.

   More the positive change in CFSE more will be lability

   $[Mn(CN)_6]^{3-} \Rightarrow Mn^{3+} = d^4$ (LS)

   $[Cr(CN)_6]^{3-} \Rightarrow Cr^{3+} = d^3$

   d^4 (LS) $\Rightarrow d^3$

   Change in CFSE -0.86 $\quad -2.00$

   Thus $[Cr(CN)_6]^{3-}$ is less labile than $[Mn(CN)_6]^{3-}$. Hence, correct order of lability or rate of exchange is

   $[Ni(CN)_4]^{2-} > [Mn(CN)_6]^{3-} > [Cr(CN)_6]^{3-}$

QUANTA CHEMISTRY CLASSES

Correct option is (d)

5. As f-orbitals are present in deep hence they have less tendency to interact with ligands. Hence, lanthanoids have smaller value of LFSE than transition metals.

Correct option is (b)

6.(a) The complex ion $[Cu(NH_3)_6]^{2+}$ has tetragonally distorted octahedral geometry due to Jahn-Teller distortion as complex has unsymmetrically filled.

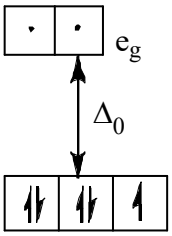
Correct answer is (b)

GATE 2006

7. Cu(I) and Hg(II) ions most commonly forms complexes with coordination number two

Correct option is (d)

8. K3 $[Fe(CN)_6]$, Fe = $3d^6\ 4s^2$, $Fe^{3+} = 3d^5$



due to presence of strong field ligand the complex from low spin complex containing one unpaired electron

$K_3[Fe(CN)_6]$	Spin only megnetic moment (B.M.)	Magnetic moment with orbital contribution (B.M.)
	1.73	2.3

Correct option is (c)

9. The Jahn-Teller effect is a geometric disortion of a non-linear system that reducess its symmetry and energy Jahn-Teller distortion shown by complexes having unsymmetrically filled energy levels.Thus, Cu(II) low-spin, Fe(III), Ti(III) will shown J.T. distoryion.

Correct option is (c)

10. The series with correct order of increasing Δ_0 in their complexes is

$I^- < PR_3 < CH_3^- < CO$

Correct option is (a)

11. $[Cd(H_2O)_6]^{2+} \underset{Br^-}{\overset{k_1}{\rightleftharpoons}} [Cd(Br)(H_2O)_5]^+ + H_2O$

$[Cd(Br)(H_2O)_5]^+ \underset{Br^-}{\overset{k_2}{\rightleftharpoons}} [Cd(Br_2)(H_2O)_3]^- + H_2O$

$[Cd(Br_2)(H_2O)_4] \underset{Br^-}{\overset{k_3}{\rightleftharpoons}} [CdBr_3(H_2O)_3]^- + H_2O$

$[CdBr_3(H_2O)_3]- \underset{Br^-}{\overset{k_4}{\rightleftharpoons}} [CdBr_4]^{2-} + 3H_2O$

Fourth equilibrium constant is observed higher than the third one becasue three molecules of H_2O are released during the fourth step ($k_4 >> k_3$)

Correct option is (b)

QUANTA CHEMISTRY CLASSES

12. There is no direct relation between thermodynamics stability and kinetic reactivity of metal ion in complexes

Correct option is (c)

13. The correct order of the rate of exchange of water molecule between the coordination sphere and the bulk is

$Cr^{3+} < Al^{3+} < Ni^{2+} < Cr^{2+}$

(1) More charge → more attraction force between metal of ligand → stronger will be the bond → less exchanging tendency.

(2) Jahn-Teller distortion leads to more exchange tendency of ligands.

(3) Cr^{3+} has less exchange tendency of H_2O molecule than Al^{3+} because in case of Cr^{3+} CFSE will be include.

Correct option is (b)

14. The correct order of the soft character (as per HSAB principle) of the central metal ion is

$[CrO_4]^{2-} < [CrCl_4]^{-} < [Cr(bipy)_3] < [Cr(CO)_5]^{2-}$

Oxidation state +6 +3 0 –2

More cationic charge on central atom → harder will be the acid

According to HSAB principle.

Hard acids prefer to bind to hard bases and soft acids prefer to bind to soft bases.

Correct option is (a)

15. The crystal structure of Pb_3O_4 contains octahedral and pyramidal units.

Correct option is (c)

16. Upon visible light excitation of $[Ru(bpy)_3]^{2+}$, the resulting metal to ligand charge transfer (MLCT) excited state species

$[Ru'''(2,2'-bipyrdyl)_2(2,2'-bipyridyl)]^{2+}$

can be reductively or oxidatively quenched with the appropriate single electron donar or acceptor.

Correct option is (d)

GATE 2007

17. In reaction (1) there is presence of bridging Cl ligand with inert complex. Hence, it follow inner sphere mechanism. In reaction (2) both omplexes are inert less they follow outersphere mechanism.

Correct option is (d)

18. In M → L charge transfer specta

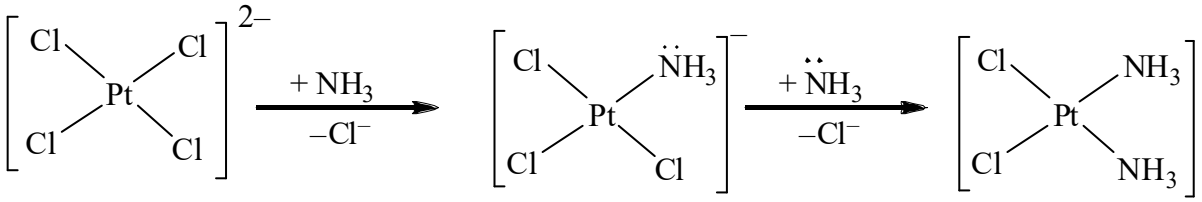
(1) Ligand should be π-acceptor in nature

(2) Metal should be in low oxidation state

Correct option is (a)

19. The reaction of $[PtCl_4]^{2-}$ with NH_3 gives rise to cis –$[PtCl_2(NH_3)_2]$

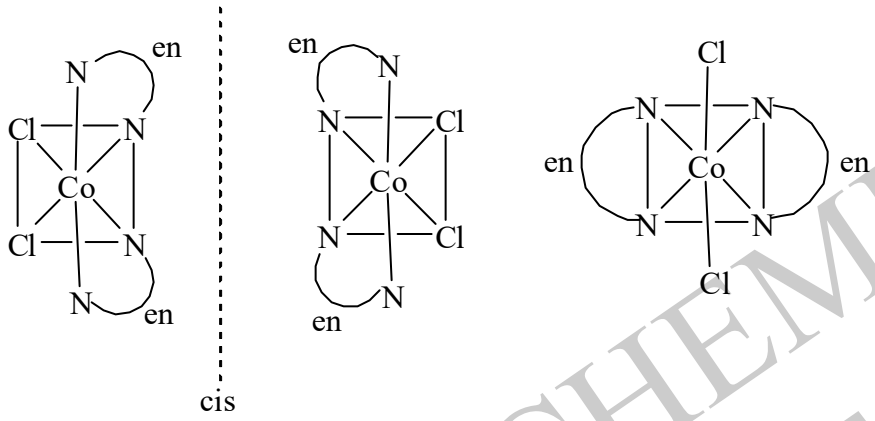
QUANTA CHEMISTRY CLASSES



Correct option is (d)

GATE 2008

20.



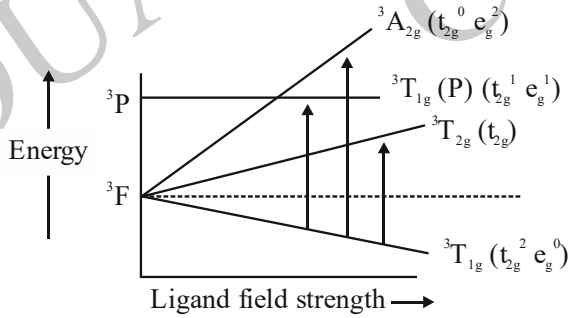
Correct option is (b)

21. $[Ru(H_2O)_6]^{2+}$ has zero unpaired electron it is low spin d^6 complex

$Ru = 4d^6\ 5s^2$ $\quad Ru^{2+}\ d^6$ (low spin) $\rightarrow t_{2g}^6\ e_g^0$

Correct option is (d)

22. The spectroscopic ground state symbol of $[Ti(H_2O)_6]^{2+}$ is T_{1g}. There are three transition in this complex and can be shown by orgel diagram.



Correct option is (c)

23. $[Cu(NH_3)_4]\ [ClO_4]_2 = [Cu(NH_3)_4]^{2+} . 2ClO_4^- \Rightarrow Cu^{2+} \Rightarrow (d^9)$

Square Planar geometry

and sp^2d hybridization

$[Cu(NH_3)_4]\ ClO_4 = [Cu(NH_3)_4]^+\ ClO_4^- \Rightarrow Cu^+ \Rightarrow d^{10}$ configuration

Hence, sp^3 hybridization and Td geometry

QUANTA CHEMISTRY CLASSES

Correct option is (b)

24. Magnetic moment of transition metal complexes is given by spin only formula

$\mu_s = \sqrt{n(n+2)}$ B.M.

Magnetic moment of Lanthanoids complexes is given by using J-value. This is due to strong spin orbit coupling in lanthanoids.

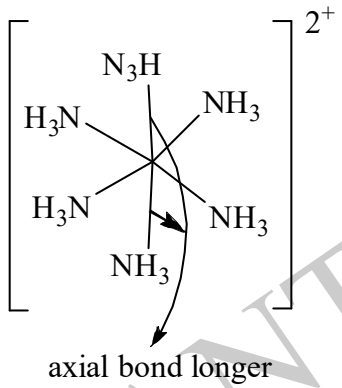
$\mu_J = g\sqrt{J(J+2)}$ B.M.

Correct option is (c)

25. The general formula of spinel is $A^{+2}B_2^{+3}O_4$. Inverse spinel, in which M^{2+} ion have a higher CFSE in a octahedral field compared to M^{3+} ion. Among the coumpounds Fe_3O_4, $NiFe_2O_4$ and Mn_3O_4 and $NiFe_2O_4$ are inverse spinels.

GATE 2009

26. $[Cu(NH_3)_6]^{2+}$ complex show Jahn-teller distortion due to which it form distorted octahedral geometry and axials bond are lorger than equitorial bond.



Correct option is (b)

27. The transformation of oxydaemoglobin to deoxyhaemoglobin Fe^{2+} involves change in low spin state to high spin state.

In deoxyhaemoglobin, Fe^{2+} is in high spin state.

In oxyhaemoglobin, iron of heme group bind with oxygen molecule, and become low spin

Correct option is (a)

28. $[Cr(C_2O_4)_3]^{3-}$ and $[V(H_2O)_6]^{2+}$ are inert orbital complexes. In both these complexes metal ion have d^3 configuration hence no low lying unhybrid vacant d-orbital. Hence, both are inert.

Correct option is (d)

GATE 2010

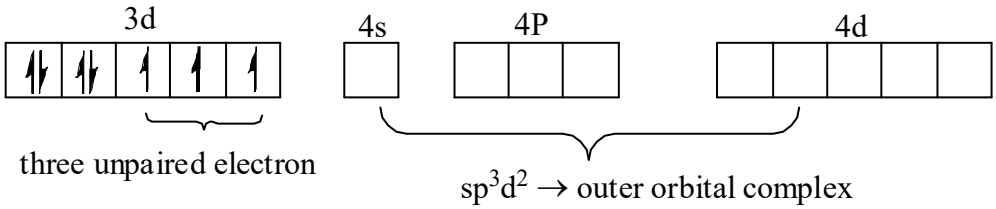
29. $[Fe(H_2O)_5\ NO]^{2+} \rightarrow x + 5 \times 0 + 1 = 2 \Rightarrow \boxed{x = +1}$

Iron is in + 1 oxidation state

QUANTA CHEMISTRY CLASSES

$Fe = 3d^6\ 4s^2$

$Fe^+ = 3d^7\ 4s^0$



Correct option is (b)

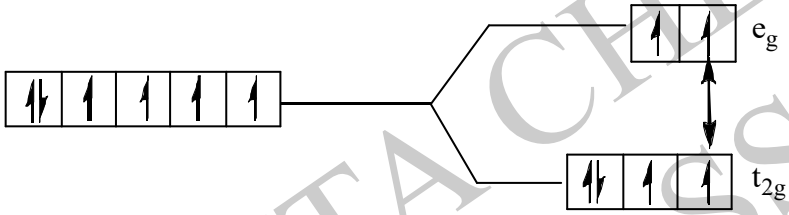
30. The general formula of spinel is $A^{+2}B_2^{+3}O4$. In normal spinel, the divalent (A^{2+}) ions occupy the tetrahedral voids whereas the trivalent (B^{3+}) ions occupy the octahedral voids. In ionverse spinel, the divalent (A^{2+}) ions occupy the octahedral voids whereas half of B^{3+} ions occupy the tetrahedral voids. Among the Fe_3O_4 and CO_3O_4, the CO_3O_4 has normal spinel structure and Fe_3O_4 has inverse spinel structure.

Correct option is (d)

31. The mechaninsm of the reaction between $[Fe(CN)_6]^{4-}$ and $[Fe(bpy)3]^{3+}$ $[Fe(bpy)3]^{3+}$ is outer sphere electron transfer.

Correct option is (a)

32. $[Fe(H_2O)_6]^{2+}$; $Fe = 3d^6\ 4s^2$; $Fe^{2+} = 3d^6$



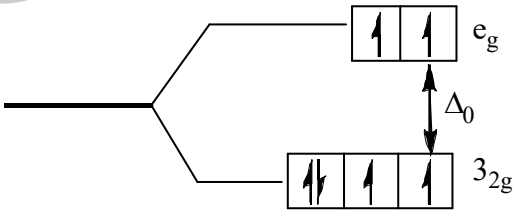
In $Fe(H_2O)_6^{2+}$, degeneracy occur in t_{2g} orbital which results into small distortion is also known as dynamic Jahn-Teller distortion.

Correct option is (c)

33. $[Mn(CN)6]^{4-}$

$Mn = 3d^5\ \ 4s^2$

$Mn^{2+} = 3d^5$



Number of unpaired electron $= 1 \rightarrow S = \frac{1}{2}$

Spin multiplicity $= 2S + 1 = 2 \times \frac{1}{2} + 1 = 2$

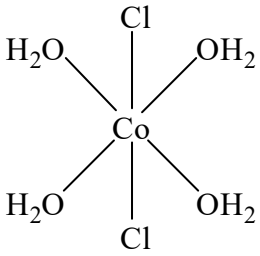
The crystal field symbol for the ground state of $[Mn(CN)_6]^{4-}$ is $^2T_{2g}$

Correct option is (a)

QUANTA CHEMISTRY CLASSES

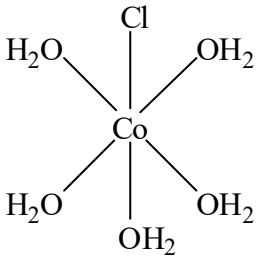
34. $[CoCl_4]^{-2} \rightarrow sp^3 \rightarrow$ tetrahedral geometry $\rightarrow$ point group $\rightarrow$ Td

$[Co(H_2O)_4Cl_2] \rightarrow$ two isomers



Trans

D_{4h}



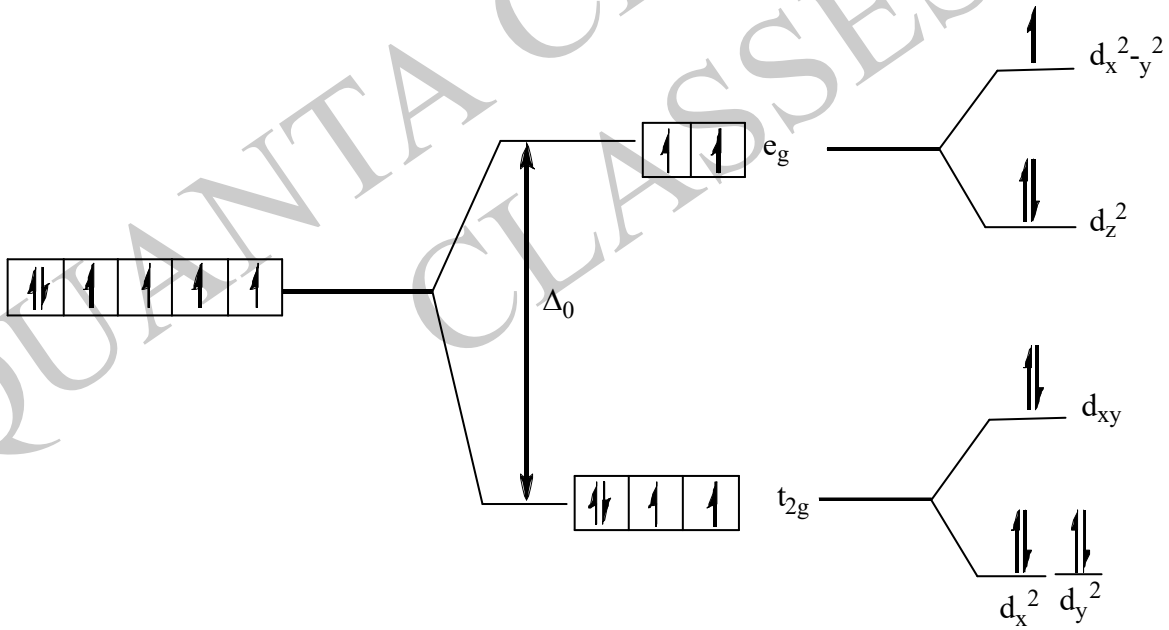
Cis

C_{2y}

Correct option is (*)

GATE 2011

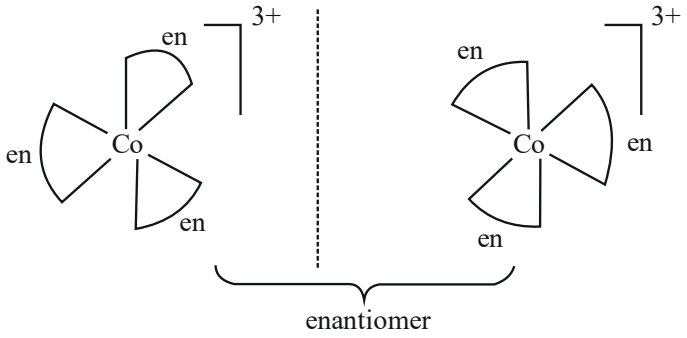
35. $CuSO_4.5H_2O$



e_g level is electronically degenerate. Janh-Teller distortion remove electronic degeneracy.

36. $[Co(H_2NCH_2CH_2NH_2)_3]^{3+}$

QUANTA CHEMISTRY CLASSES



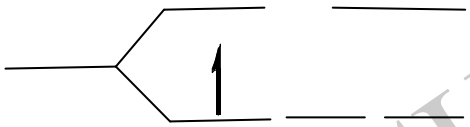
Correct option is (d)

37. Absorption maximum (λ) = 492 nm = 492×10^{-9} m = 492×10^{-7}n

splitting energy (Δ) = $\frac{1}{492 \times 10^{-7}\ \text{cm}} = 0.00203252 \times 10^{7}\ \text{cm}^{-1} = 20325.2\ \text{cm}^{-1}$

$\Delta = 20325.2\ \text{cm}^{-1}$

CFSE for $[Ti(H_2O)_6]^{3+}$ complex,

$Ti^{2+}\ d^1(Oh)$ 

CFSE = $0.4 \times 20325.2\ \text{cm}^{-1} = 8130\ \text{cm}^{-1}$

Correct option is (d)

38. Higher the oxidation state of metal $\propto$ higher will be the wavelength for transition

$$\underset{\lambda \text{ for LMCT}}{\overset{5+}{VO_4^{3-}} < \overset{6+}{CrO_4^{2-}} < \overset{7+}{MnO_4^{+}}}$$

Correct option is (b)

39. CFSE $\propto \frac{1}{\lambda} \propto$ field strength of ligand

$$\underset{\text{order of field strength of ligand}}{Cl^- < H_2O < NH_3 < CN^-}$$

The correct order of wavelength of absorption for the complex ions.

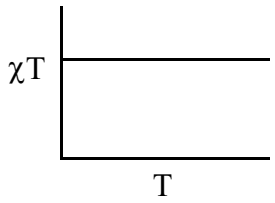
$$\underset{\text{order of wavelength of absorption}}{[Cr(CN)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(H_2O)_6]^{3+} < [Cr(Cl)_6]^{3-}}$$

Correct option is (c)

QUANTA CHEMISTRY CLASSES

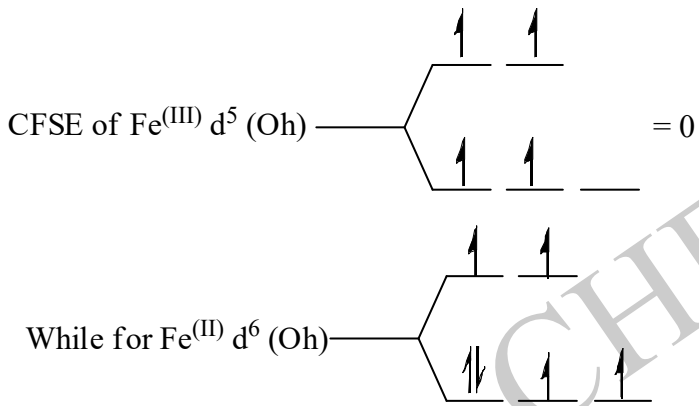
GATE 2012

40. Plot of magnetic susceptibility versus T for paramagnetic



Correct option is (c)

41. Fe_3O_4 is a inverse - spinel; $Fe^{(II)}\ Fe_2^{(III)}O_4$



Hence, it will be inverse spinel.

Correct option is (b)

42. The IUPAC nomenclature of $Na[PCl_6]$ is sodium hexachlorophosphate (V)

Correct option is (b)

43. As the size of halide increases bridging tendency increases. Hence, the rate of electron trasfer also increases.

$F^- < Cl^- < Br^- < I^-$

The electron transfer rate will be fatest in

$[CoI(NH_3)_5]^{2+}$ and $[Cr(H_2O)_6]^{2+}$

Correct option is (d)

GATE 2013

44. Experimental hydration Energy = Theoretical hydration + CFSE energy

$[V_2(H_2O)_6]^{2+}$: $V^{2+} \rightarrow 3^{d3} \rightarrow t_{2g}^3\ e_g^0$

$CFSE = -0.4 \times 3 + 0 = -1.2\Delta_0$

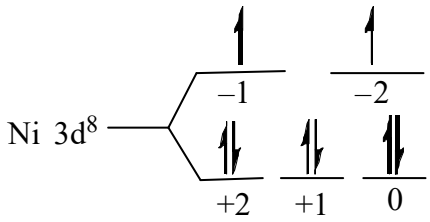
$[V(H_2O)_6]^{2+}$ complex has higher CFSE among the four. Hence, has maximum enthalpy of hydration

Correct option is (c)

45. In $[Ni(H_2O)_6]^{2+}$

$Ni^{++} = 3d^8$

QUANTA CHEMISTRY CLASSES

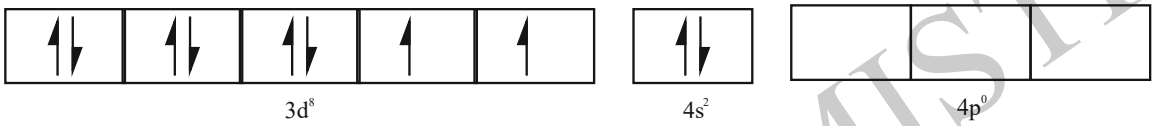


Therefore, L = 3 i.e. 'F' Term and spin multiplity = 2s + 1 = 2 + 1 = 3 i.e ^3F term splits into $^3A_{2g}$ $^3T_{2g}$, $^3T_{2g}$, $^3T_{1g}$ with ground state term $^3A_{2g}$. with ground state term $^3A_{2g}$.

Correct option is (c)

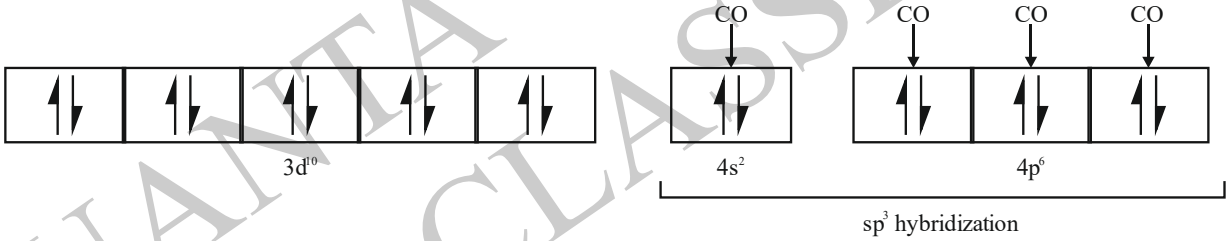
GATE 2014

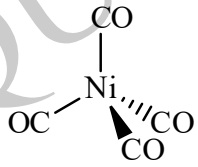
46. Electronic configuration of Ni

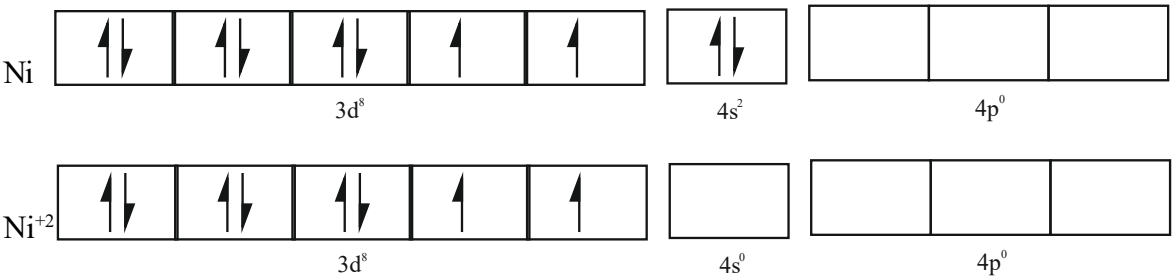


Change in electronic configuration of Ni atom when CO ligand aproach it.

Electronic configuration of Ni in $Ni(CO)_4$

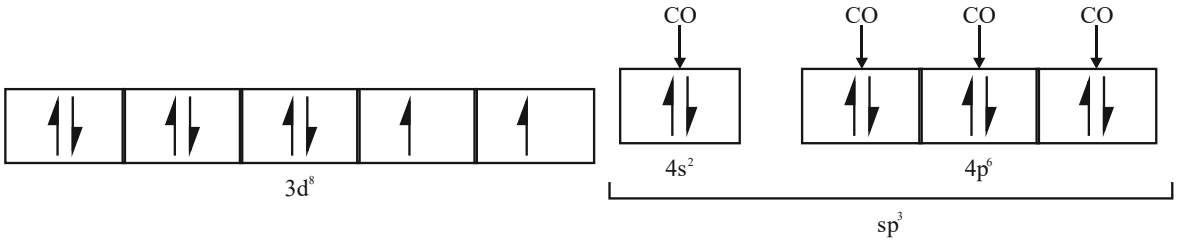


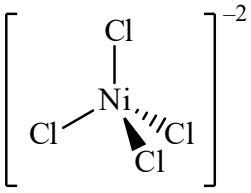




$[NiCl_4]^{2-}$

QUANTA CHEMISTRY CLASSES





Correct option is (c)

47. $[Co(H_2O)_4\ Cl_2]\ NO_2\ [Co(H_2O)_4\ Cl(NO_2)]Cl$

In this complex there is exchange of ligand between coordination sphere and ionization sphere called ionisation isomerism.

Correct option is (c)

48. The number of microstate for a given term = $(2s + 1)\ (2L + 1) = (2 \times 0 + 1)\ (2 \times 4 + 1) = 9$

Correct option is (9)

49. The distortion in the geometry of the non-linear molecular system is called Jahn-Teller distortion

$[Ti(H_2O)_6]^{3+}$ $[Co(H_2O)_6]^{2+}$

$Ti^{3+}\ (3d^1) \rightarrow t_{2g}^1\ e_g^0$ $Co^{2+}(3d^7) \rightarrow t_{2g}^5\ e_g^2$

$[Fe(H_2O)_6]^{2+}$ $[Cr(H_2O_6)]^{2+}$

$Fe^{2+}\ (3d^6) \rightarrow t_{2g}^4\ e_g^2$ $Cr^{2+}\ (3d^4) \rightarrow t_{2g}^3\ e_g^1$

Unsymmetric configuration in e_g set causes strong Jahn-teller distortion.

Correct option is (a)

50. Magnetic moment depend upon nuber of unpaired electron

$[Ni(CN)_4]^{2-}$ $Ni^{2+} = 3d^8 \longrightarrow t_{2g}^6\ e_g^2$

$[Fe(CN)_6]^{3-}$ $Fe^{3+} = 3d^5 \longrightarrow t_{2g}^5\ e_g^2$

$[Cu(H_2O)_6]^{2+}$ $Cu^{2+} = 3d^9 \longrightarrow t_{2g}^6\ e_g^3$

$[Co(CN)_6]^{3-}$ $Co^{3+} = 3d^6 \longrightarrow t_{2g}^6\ e_g^0$

In case of $[Fe(CN)_6]^{3-}$ there is orbital contribution hence have high magnetic moment.

Correct option is (b)

51. In normal spinel A(II)ions occupy the tetrahedral voids whereas the trivalent B(III) ions occupy the octahedral voids.

$Mn^{2+}\ Cr_2^{3+}O_4$

$Mn^{2+} \rightarrow 3d^5$ $Cr^{3+} \rightarrow 3d^3$

Tetrahedral Tetrahedral

$Cr^{3+} \rightarrow 3d^3 \rightarrow e^2t_2^1$

$Mn^{2+} \rightarrow 3d^5 \rightarrow e^2t_2^3$ $CFSE = (-0.6 \times 2 + 0.4 \times 1)\ \Delta_t$

QUANTA CHEMISTRY CLASSES

$= (-1.2 + 0.4)\Delta_0 = -0.8\ \Delta_t$

CFSE = $(-0.6 \times 2 + 0.4 \times 3)\Delta_0 = 0$

Octahedral Octahedral

$Mn^{2+} \rightarrow 3d^5 \rightarrow t_{2g}^3\ e_g^2$ $Cr^{3+} \rightarrow 3d^3 \rightarrow t_{2g}^3\ e_g^0$

CFSE = $(-0.4 \times 3 + 0.6 \times 2)\ \Delta_0$

$= (-1.2 + 1.2)\Delta_0 = 0$ CFSE = $-0.4 \times 3\Delta_0 + 0 = -1.2\Delta_0 = -15Dq$

$= (-1.2 + 1.2)\ \Delta_0 = 0$

There is two Cr^{3+} ion

NET CFSE = (–12Dq) + (–12Dq) = –24Dq

Correct option is (c)

GATE 2015

52. The absorption spectrum of $[Ti(H_2O)_6]^{3+}$ in solution comprises of a maximum with a shoulder. The reason for the shoulder is Jahn-teller distortion.

Correct option is (c)

53. Metal to ligand charge transfer (MLCT) like in $[Fe(bpy)_3]^{2+}$. In this complex the charge transfer occurs from Fe(II) to the empty π^* orbital of bpy ligand.

Correct option is (a)

54. $K_2[NiF_6]$

$Ni^{4+} = 3d^6$

Due to presence of +4 oxidation of metal it form low spin complex (diamagnetic in nature) having configuration $t_{2g}^6\ e_g^0$.

$K_3[CoF_6]$ $Co^{3+} = 3d^6 \rightarrow$ high spin due to presnece of weak field having configuration $t_{2g}^4\ e_g^2$

(paramagnetic in nature)

Correct option is (d)

55. Crossing point rises the activation energy increases and the rate of electron transfer becomes slower. The increasing order of the rate constant is

$k_3 < k_1 < k_2$

Correct option is (d)

GATE 2016

56. The selection rules governing transitions between electronic energy levels of transition metal complexes are in d-d transition if $\Delta S = 0$, spin allowed (transition in same spin)

$[M(H_2O)_6]Cl_2$

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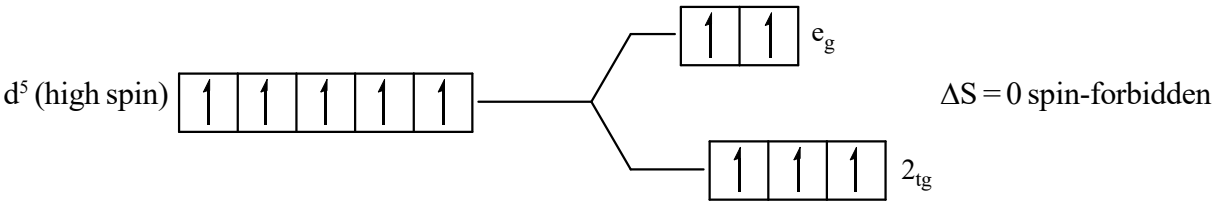
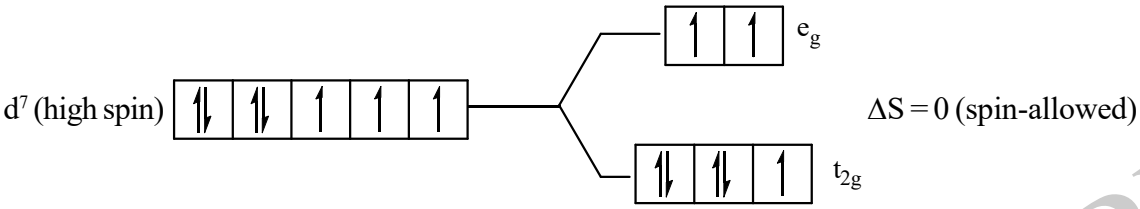




Correct option is (c)

57. In contrast to s, p block metal, transition metal possess vaccant d-orbital which involve kinetically facile reaction such as β-H elimination, alkene insertion, etc. which leads to transformation of alkyl ligand into other group.

Hence, compond which have β-hydrogen w.r.t. metal are unstable.

Correct option is (c)

58. According to Irving-Williams series, the stability of complexes with di-positive metal ion follows the order

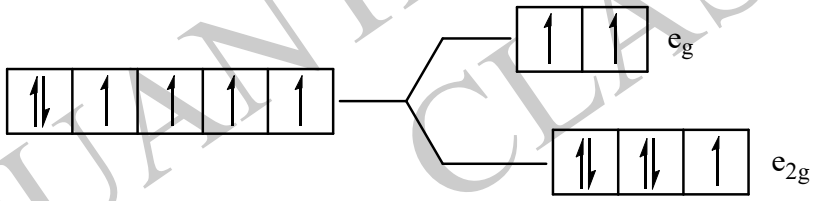
$Ba^{2+} < Sr^{2+} < Ca^{2+} < Mg^{2+} < Mn^{2+} < Fe^{2+} < Co^{2+} < Ni^{2+} < Cu^{2+} > Zn^{2+}$

Therefore, the number of d-electrons for the first row transition metal (M) i.e. Cu^{2+} ion having highest overall stability constant (log B) for $[MEDTA]^{2-}$ is nine (9)

Correct answer is (9)

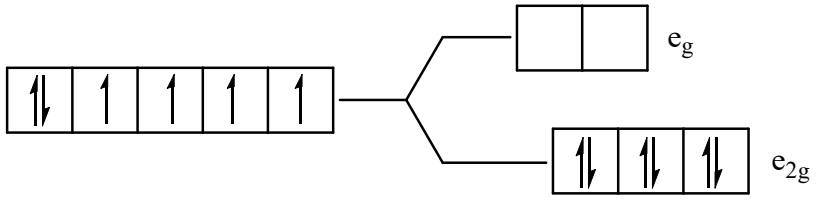
59. $[Fe(H_2O)_6]^{2+} \rightarrow$ high spin

$Fe = 3d^6 4s^2$; $Fe^{2+} = 3d^6$



$CFSE_1 = (-0.4 \times 4 + 2 \times 0.6)\Delta_0 = (-1.6 + 1.2)\Delta_0 = -0.4\Delta_0$

$[Fe(CN)_6]^{4-} \rightarrow$ low spin; $Fe^{2+} = 3d^6$



$CFSE_2 = -0.4 \times 6\Delta_0 + 0 = -2.4\Delta_0$

Difference in CFSE = $CFSE_1 - CFSE_2 = -0.4\Delta_0 - (-2.4\Delta_0) = 2.0\Delta_0$

Correct answer is (2.0)

60. In electronic spectra of $[CrF_6]^{3-}$ shows three transition

$^4T_g \rightarrow {}^4A_{2g}$ $\quad E_1 = \nu_1 = 670$ nm

QUANTA CHEMISTRY CLASSES

$^4T_{1g}$ (f) $\rightarrow$ $^4A_{2g}$ $E_2 = \nu_2 = 440$ nm

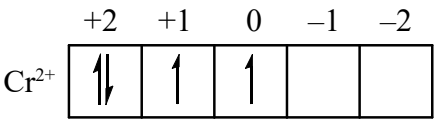
$^4T_{1g}$ (p) $\rightarrow$ $^4A_{2g}$ $E_3 = \nu_3 = 290$ nm

Correct option is (d)

GATE 2017

61. $[Cr(CN)_6]^{4-}$

$Cr^{2+} = 3d^4$



$L = +2 + 2 + 1 + 0 = 5(H)$

$S = + \frac{1}{2} + \frac{1}{2} = 1$

Multiplicity $= 2S + 1 = 2 \times 1 + 1 = 3$, hence term symbol $= {}^3H$

Correct option is (b)

62. Energy of charge transfer increases in the following order

$VO_4^{3-} > CrO_4^{2-} > MnO_4^-$

The corect order of wavelength of transition is

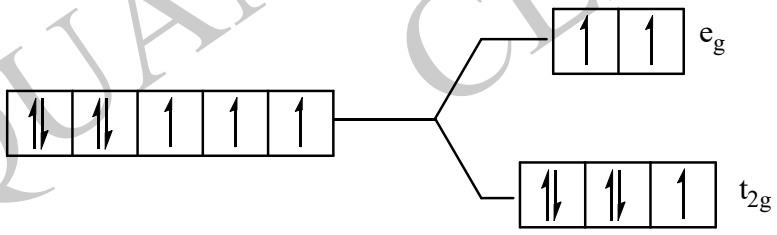
$VO_4^{3-} < CrO_4^{2-} < MnO_4^-$

Correct option is (c)

63. $[Co(NH_3)_6]^{2+} \rightarrow$ high spin

$Co \rightarrow 3d^7\ 4s^2$

$Co^{2+} \rightarrow 3d^7$



CFSE $= [-0.4 \times 5 + 0.6 \times 2]\Delta_0 = (-2.0 + 1.2)\Delta_0$

CFSE $= -0.8\Delta_0$

Correct option is (c)

64. $MgAl_2O_4$ is atype of normal spinel in which

All $Mg^{2+} \rightarrow$ occupied $\frac{1}{8}$ of tetrahedral void

All $Al^{3+} \rightarrow$ occupied $\frac{1}{2}$ of octahedral void

Correct option is (d)

QUANTA CHEMISTRY CLASSES

GATE 2018

65. Rate of water exchange $\propto \frac{1}{\text{oxidation state}}$

It also depend upon electronic configuration (fkor ions having same oxidation state) ions havveing d^3 configuration show water excange lesser as compaed to d^7 configuration. Hence, order of H_2O exchange is

$$\underset{d^7}{[Co(H_2O)_6]^{2+}} > \underset{d^3}{[V(H_2O)_6]^{2+}} > \underset{d^3}{[Cr(H_2O)_6]^{3+}}$$

Correct option is (d)

66. Storger the ligand will be Δ_0 hence more energy will require for d-d transition. Order of energy for d-d transition will be

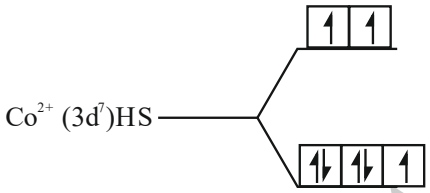
$$[Cr(H_2O)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-}$$

Correct option is (a)

67. p-obitals have t_{lu} symmetry in Oh field

Correct option is (b)

68. $[Co(H_2O)_6]^{2+}$

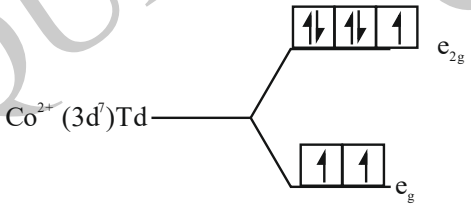


$S = \frac{3}{2}$, $2s + 1 = 4$

This complexes is electronically triply degenerate in ground state.

Therefore, ground state term $*T_{1g}$

$[CoCl_4]^{2-} \rightarrow$ Tetrahedral



Spin multiplicity $= 2 \times \frac{3}{2} + 1 = 4$

$[CoCl_4]^{2-}$ is electronically non-degenerate in ground states

Therefore, Ground state term $\rightarrow {}^4A_2$

Correct option is (b)

69. $NiGa_2O_4$ in inverse spinel while other are normal spinel

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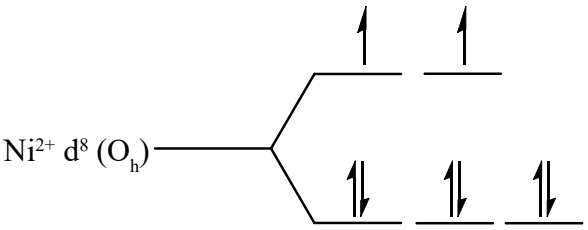


$Ga^{3+} = s^0p^0d^6$ hence zero CFSE due to this Ni^{2+} will occupy O_h void hence it is an inverse spinels

Correct option is (a)

GATE 2019

70.Sol. Δ_0 value of $[Ni(OH_2)_6]^{2+} = 8500\ cm^{-1}$

which suggest energy gap between t_{2g} and e_g levels.

Ligand field strength as per spectrochemical series

$$Cl^- < H_2O < NH_3$$

It means NH_3 generates larger splitting whereas Cl^- produces smaller splitting compared to water and hence Δ_0 value for $[NiCl_6]^{4-}$ is lower than $[Ni(OH_2)_6]^{2+}$

Also, Δ_0 value for $[Ni(NH_3)_6]^{2+}$ is higher than $[Ni(OH_2)_6]^{2+}$

72.Sol. No. of moles of AgBr formed $= \dfrac{0.94}{188g}$

$= 5 \times 10^{-3}$ moles.

No. of moles of $CrBr_3 \cdot 6H_2O$ in 1g amount.

$$= \frac{1}{400}$$

$= 2.5 \times 10^{-3}$ moles

It means given complex should give 2 Br^- ions per formula unit of salt.

$$[Cr(OH_2)_5Br]Br_2 \cdot H_2O \rightarrow [Cr(OH_2)_5Br]^{2+} + 2Br^-$$
$$2.5\times10^{-3}\ \text{mole} \qquad\qquad 5\times10^{-3}\ \text{mole}$$

So Given Complex salt is $[Cr(OH_2)_5Br]^{2+}$.

73Sol. $[Co^{III}(NH_3)_5X]^{3+/2+} + [Cr^{II}(H_2O)_6]^{2+} \rightarrow [Co^{II}(NH_3)_5(H_2O)]^{2+} + [Cr^{III}(H_2O)_5X]^{3+/2+}$

When X = NH_3 which is a stronger field ligand for Co^{+3} makes low spin $[Co(NH_3)_6]^{3+}$ with highest possible CFSE of –24Dq. This appreciable CFSE accounts for immense stability of $[Co(NH_3)_6]^{3+}$ complex and hence it is most reluctant to undergo redox process.

74Sol. Zn^{2+} is a d^{10} system whereas Fe^{+3} is d^5. Both have 0 CFSE

Fe^{+3} enjoys greatly high lattice energy in octahedral void and hence cannot be substituted by Zn^{2+} ion. Therefore, $ZnFe_2O_4$ is a normal spinel system.

QUANTA CHEMISTRY CLASSES

GATE 2020

75.Sol.: Number of microstate $= \dfrac{n!}{(n-r)!\,r!}$

n is twice of number of orbital r is number of e^-.

For d^2; n = 10

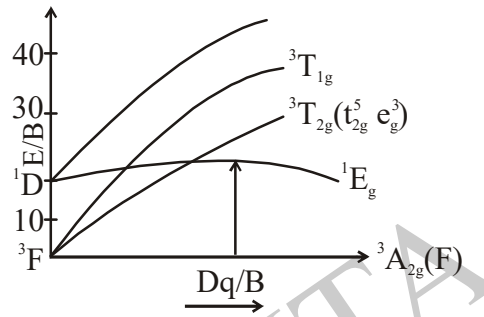
r = 2

76.Sol.: $\left[Ni(NH_3)_6\right]^{2+}$ d^8 system

two spin-forbidden transition.

$3A_{2g}(F) \rightarrow {}^1E_2(D)$

$3A_{2g}(F) \rightarrow {}^1T_{2g}(D)$ are observed.



Transition ${}^3A_{2g}(F) \rightarrow {}^1E_g$ observed in between

${}^3A_{2g} \rightarrow {}^3T_{2g}$ and ${}^3A_{2g} \rightarrow {}^3T_{1g}(F)$

Correct option is (a)

$$\frac{10!}{8!\times 2!} = \frac{10\times 9\times 8!}{2!\times 8!} = 45$$

Correct answer is (45)

GATE 2021

77.Sol. Nickel in the complex $[NiBr_2(PPh_3)_2]$ is n + 2 oxidation state risred coloured it is observed to be diamagnetic which indicates that the complex is square planar in nature.

The complex $[NiBr_2(PPh_3)_2]$, immediately transforms to a green coloured complex & it is observed to be paramagnetic.

Ni(+2) complexes will be paramagnetic only when they are tetrahedral and octahedral. So this complex has coordination number 4 so, it is tetrahedral.

$[NiBr_2(PPh_3)_2]^{2+} \rightarrow Ni^{2+} \rightarrow d^8$

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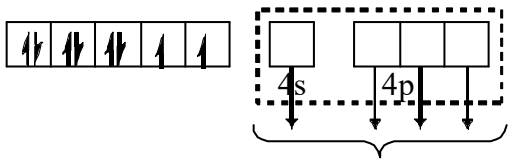


sp^3 hybridisation

Number of unpaired $e^{\Theta} = 2$

So, correct option is (b)

78Sol. Co^{2+} complex will follow the dissociative mechanism.

$$\left[Co(CN)_5Cl\right]^{3-} \longrightarrow \left[Co(CN)_5\right]^{2-} \xrightarrow{OH^-} \left[Co(CN)_5(OH)\right]^{3-}$$

the rate thus depends on the complex $[Co(CN)_5Cl]^{3-}$ and not on the concentration of OH^- ion.

Correct option is (c)

79 Sol. $K_2CrO_4 + HCl \rightarrow K_2Cr_2O_7$

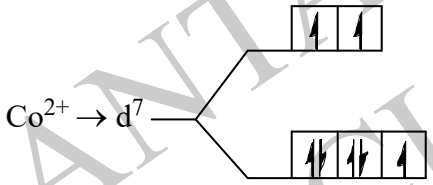
In dichromate complex central metal is in +6 oxidation state and has no electron in d orbital. Therefore d-d transitions are not possible. The colour of complex is due to charge transfer from ligand to metal.

80 Sol. According to spectrochemical series the order of Δ_0.

$[Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+} > [CrF_6]^{3-}$

Correct option is (d)

81. Sol. In $[Co(H_2O)_6]^{2+}$ complex with is weak field ligand. So it is high spin complex.



Number of unpaired electron = 3

Hence, the magnetic moment $\mu = \sqrt{n(n+2)}$

$$= \sqrt{3(3+2)}$$

$$= \sqrt{3\times 5}$$

$$= 3.87 \text{ BM}$$

Hence the spin only magnetic moment of $[Co(H_2O)_6]^{2+}$ is 3.9 BM.

82.Sol.

	Molar absorbed
$[Ti(H_2O)_6]^{3+}$ → Spin allowed laporte forbidden	8 – 10
$[Mn(H_2O)_6]^{2+}$ → Spin forbidden laporte forbidden	0.1 – 0.2
$[CrO_4]^{2-}$ → Spin allowed laporte allowed	$10^3 – 10^4$
$[NiCl_4]^{2-}$ → Spin allowed laporte partly allowed	$10^2 – 10^3$

So correct order of increasing intensity will be

QUANTA CHEMISTRY CLASSES

$[CrO_4]^{2-} > [NiCl_4]^{2-} > [Ti(H_2O)_6]^{3+} > [Mn(H_2O)_6]^{2+}$

Correct option is (c)

QUANTA CHEMISTRY CLASSES

ORGANOMETALLIC COMPOUNDS

GATE 2005

5. According to neutral atom method of 18 electron count:

(a) $(\eta^5 - C_5H_5)\ Fe(CO)_2$

Fe $\Rightarrow$ 8e–

2CO $\Rightarrow$ 4e–

$\eta^5Cp \Rightarrow \dfrac{5e^-}{14e^-}$

(b) $(\eta^5 - C_5H_5)\ Mo(CO)_3$

Mo $\Rightarrow$ e–

3CO $\Rightarrow$ 6e–

$\eta^5Cp \Rightarrow \dfrac{5e^-}{17e^-}$

(c) $(\eta^5Cp)_2\ Co$

Co $\Rightarrow 9e^-$

$2\eta^5Cp \Rightarrow \dfrac{10e^-}{19e^-}$

(d) $(\eta^5 - C_5H_5)\ Re\ (\eta^6C_6H_6)$

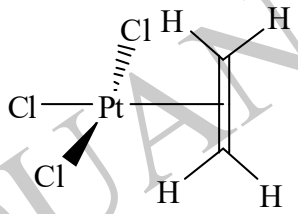
Re $\Rightarrow 7e^-$

$\eta^5Cp \Rightarrow 5e^-$

$\eta^6C_6H_6 \Rightarrow \dfrac{6e^-}{18e^-}$

Correct option is (d)

33. The substituent present on ethelene affect the π back bonding.

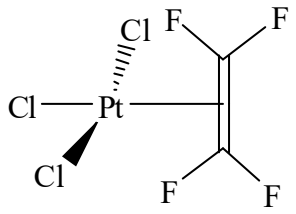


ERG increase electron density on alkene therefore increases the π donation ability of alkene to metal. As a result π back bonding decreases

Hence M–C bond length increases.

C–C bond length decreases.

QUANTA CHEMISTRY CLASSES



EWG on alkene enchances the π back bonding, as a result.

M – C bond length decrease

C – C bond length increase

Correct option is (b)

35. As back donation between metal-carbonyl increases M–C bond length decreases hence stretching frequency increases.

I > II > III

43. Wilkinson's catalyst → $RhCl(PPh_3)_3$ I. trans – $IrCl(CO)(PPh_3)_2$

Speiers's catalyst → Hydrosilyation

Water gas shift catalyst → Zinc-copper oxide.

Zeolite ZSM-5 catalyst → Synthetic gasoline.

Correct option is (a)

72. $[Re_2C_8]^{2-}$ is royal blue due to transition $\delta \rightarrow \delta^*$

Correct option is (a)

GATE 2006

41. $Co(CO)_4 \Rightarrow$ Valence electron of fragment = 17 electron

$CH_3 \Rightarrow$ Valence electron $\Rightarrow 7$

Correct option is (b)

42. $[Ti(Co)_6]^{2-}$ $[V(CO)_6]^{-}$ CO, $[Cr(CO)_6]$

↓ ↓ ↓

1750cm^{-1} 1860cm^{-1} 2143cm^{-1} 2000cm^{-1}

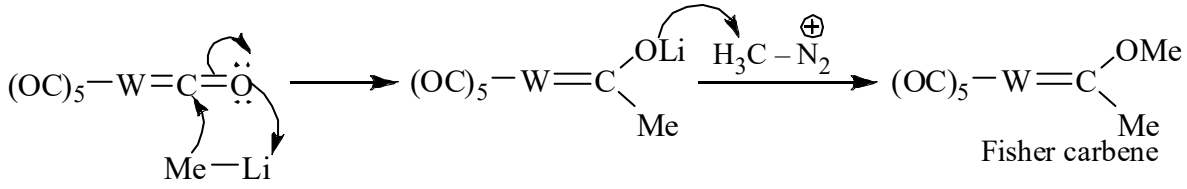
As the electron density on metal increases back bonding increase. Hence, metal to carbon strength increases and C–O bond strength in carbonyl decreases.

$CO > [Cr(CO)_6] > [V(CO)_6]^{-} > [Ti(CO)_6]^{-2}$

Correct option is (d)

GATE 2007

23.



Correct option is (c)

24. $[Re_2Cl_4(PMe_2Ph)_4]_+$

QUANTA CHEMISTRY CLASSES

Step (1) : Let the oxidation state of 'R' atom is x

$2x - 4 = +1 \Rightarrow 2x = +5$

$Re^{+2} = 4d^5$ $Re^{3+} = 4d^4$

Step (2) : There fore, number of d electron on Re^{+2} and Re+3 ions

$= 5 + 4 = 9$

Step (3) : Electronic configuration in cluster ion is

$\sigma^2\ \mu^4\delta^2\sigma^{*1}$

$$B.O = \frac{1}{2}(8-1) = 3.5$$

Similarly $[Re_2Cl_4(PMe_2Ph)_4]$ Step (1) $\Rightarrow 2x - 4 = 0 \Rightarrow 2x = +4 \Rightarrow x = +2$

$Re^{+2} = 4d^5$ $Re^{+2} = 4d^5$

Step (2) = 5 + 5 = 10

Step (3) = $\sigma^3\ \pi 4\ \delta 2\ \delta^{*2}$; $\frac{1}{2}\ (8-2) = 3$

Corret option is (d)

28. According to neutral atom method of 18 electron count (TVE)

$[Ni_2(\eta^5 - C_p)_2(CO)_2]$ = 2 Ni = 20 electron

$2\eta^5C_p$ = 10 electron

2CO = 4 electron

TVE = 34 electron

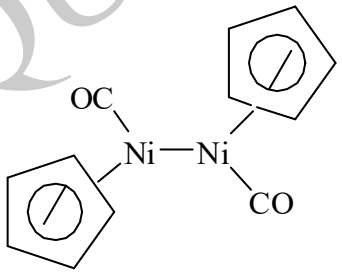
$B = n \times 18 - TVE$ where, n = number of metal in cluster

$= 2 \times 18 - 34$

$= 36 - 34 = 2$

$\frac{B}{2}$ = number of M–M bond $\frac{2}{2} = 1$

$\nu_{CO} = 1857\ cm^{-1}$ suggest ter min al carbonyl



As ν_{co} for M–CO terminal = 2120 – 1850 cm^{-1}

Per 'Ni' atom valence electron = 18 electron

Correct option is (c)

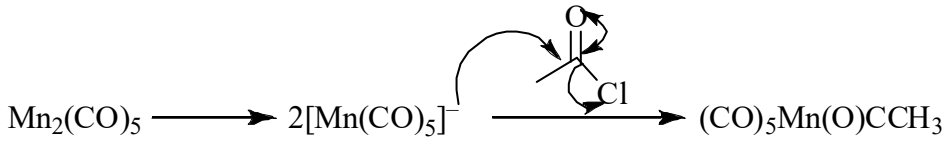
29. $[B_5H_5]^{-2} \Rightarrow [B_nH_n]^{-2} \Rightarrow$ closo

$[B_5H_9] \Rightarrow [B_5H_5]^{-4} \Rightarrow [B_nH_n]^{-4} \Rightarrow$ Nido

$[B_5H_{11}]\ [B_5H_5]^{-6} \Rightarrow [B_nH_n]^{-6} \Rightarrow$ Arachano

Correct option is (c)

QUANTA CHEMISTRY CLASSES

33. 

Carbonylate ion nucleophillic in nature

correct option is (b)

38. Wecker's process

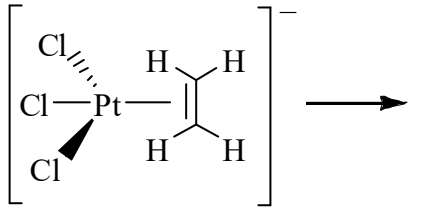
$C_2H_4 + H_2O + [PdCl_4]^{-2} \longrightarrow CH_3CHO + Pd + 2HCl + 2Cl^-$

$Pd + 2CuCl_2 + 2Cl^- \longrightarrow [Pd(Cl_4)]^{-2} + 2CuCl$

$2CuCl + ½\ O_2 + 2HCl \longrightarrow 2CuCl_2 + H_2O$

Net reaction $C_2H_4 + ½\ O_2 \longrightarrow CH_3CHO$

Correct option is (b)

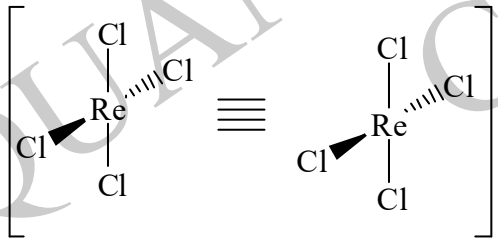
37. 

$\longrightarrow [PtCl3(\eta_2-C_2H_4)]^-$

Zeise's Salt

Correct option is (d)

GATE 2008

2. 

Correct option is (d)

26. The correct order of bronsted acidity of boron hydrides follows the order

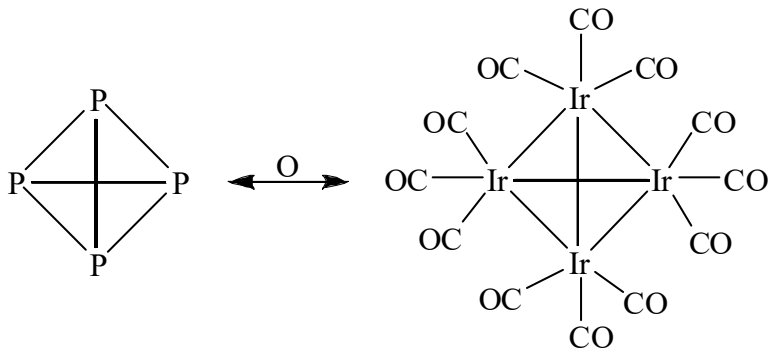
$B_{10}H_{14} > B_5H_9 > B_4H_{10} > B_2H_6$

acidity of boron hydride depends on the size of borane greater the size higher will be acidity. This is because the negative charge, formed upon deprotonation, can be better delocalized over a larger anion with many boron atoms than over a small one.

Correct option is (c)

QUANTA CHEMISTRY CLASSES

32.



TEC = $9 \times 4 + 12 \times 2 = 60 \quad \Rightarrow \quad (14n + 4)$

PEC $\Rightarrow 60 - 4 \times 12 = 12$

$\frac{PEC}{2} \Rightarrow \frac{12}{6}\ 6 \Rightarrow (n + 2)$ hence Nido

Correct option is (b)

34. $Ir_4(CO)_{12}$

TVE = $9 \times 4 + 12 \times 2 = 36 + 24 = 60$

A = $n \times 18 - TVE$ where, n = number of metal

$= 4 \times 18 - 60 = 72 \times 60 = 12$

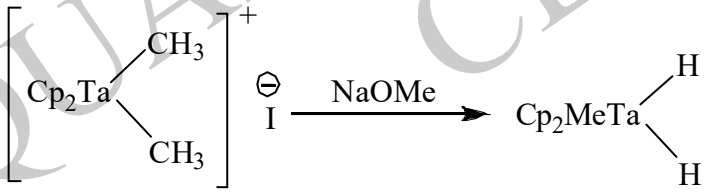
B = 12

B/2 Total number of m-m bond

Then, $\frac{12}{2} = 6$

Correct option is (b)

35. Shrock's carbene



Triplets and Nucleophilic

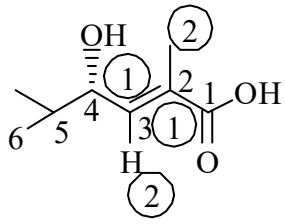
Shrock's carbene

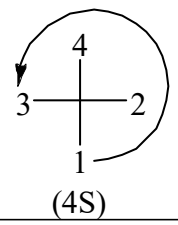
Nucleophilic nature is due presence of strong σ donor ligands.

Correct option is (a)

GATE 2009

8.





(4S)

2E, 4S

QUANTA CHEMISTRY CLASSES

Correct option is (d)

21. $\nu_{CO} \propto \frac{1}{\text{electron density on metal}}$

electron density on metal decreases then M–C bond strength decreases

C–O bond strength increases

NMe_3 is stronger σ-donar

PX_3 are σ – donar as well as π – acceptor

The σ – donating ability $NMe_3 > PMe_3 > P(OPh)_3 > PCl_3$

Hence, ν_{CO} – Mo $(CO)_3$ PCI_3 > $Mo(CO)_3$ $P(OPh_3)$ > $Mo(CO)_3$ $(PMe_3)_3$ > $Mo(CO)_3$ $(NMe_3)_3$

Correct option is (c)

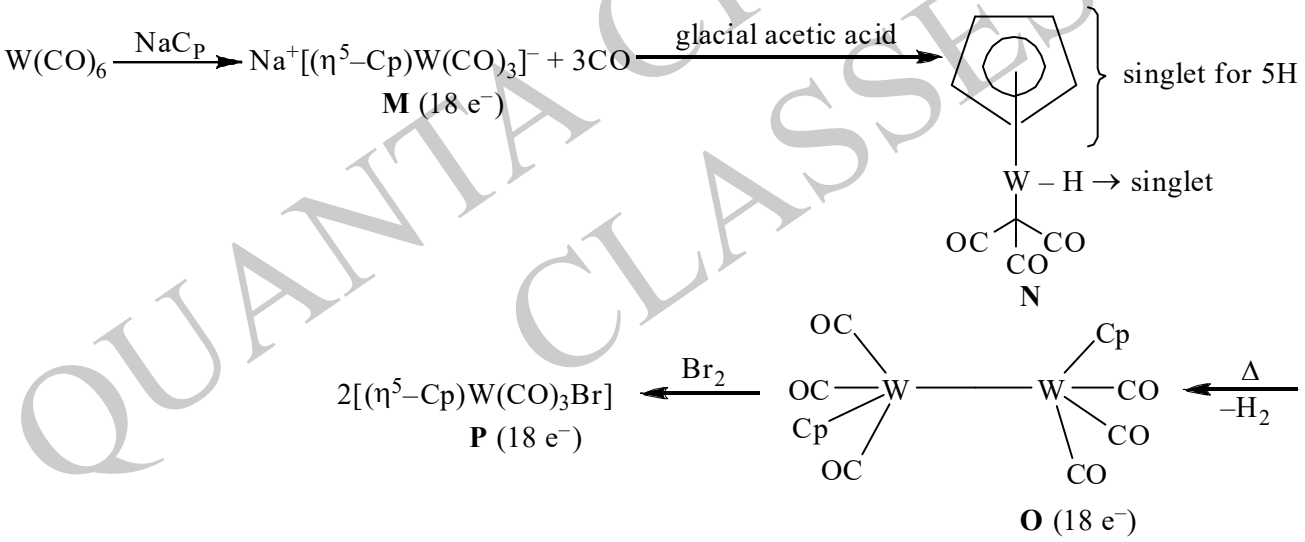
23. $Ph_3P + Me{-}I \longrightarrow (Ph_3P - (Me))(I)$

$Ph_3P{-}CH_2{-}H \xrightarrow{nBuLi} Ph_3P{-}CH_2 \longrightarrow Ph_3P{=}CH_2$

Correct option is (b)

51. (51.52)

Solution for 51 and 52.



Hence Q.51, Correct option is (a) and in Q.52. Corect option is (a)

GATE 2010

5. Framwork electron pairs are calculated by wade rules as

$$FEP = \frac{3B+1H+4C+x-2n}{2} = \frac{3\times12+1\times12+4\times0+2-2\times12}{2} = \frac{36\times12+2-24}{2} = \frac{26}{2} = 13$$

Where, B = number of boron atoms

H = number of hydrogen atoms

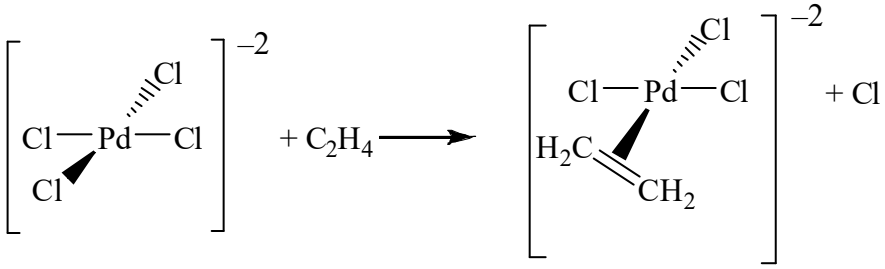
C = number f carbon atom

x = negative charge

n = B + C

Correct option is (c)

6.



The C–C bond of ethelene become large when coordinate with Pd because, the electron density from metal to shift in to π* orbital of ethylene.

Correct option is (a)

8. Nickellocene (Cp_2Ni) is $20e^-$ species. The electronic configuration of $C_{P_2}\ Ni - e_{2g}^4\ a_{1g}^2\ e_{1g}^{*2}$.

Nickellocence are less stable and easily oxidised or loss two electron from antebonding e_{1g}^* to give 18 electron $C_{P_2}\ Ni^{2+}$ ion.

Correct option is (b)

GATE 2011

30. $Ru_3(CO)_{12}$ TVE 3 Ru ⇒ 8 × 3 = 24 electron

12CO ⇒ 12 × 2 = 24 electron

TVE = 48 electron

B = n × 18 – TVE, n = number of metal

= 3 × 18 – 48

= 54 – 48 = 6

$\frac{B}{2}$ = number of M—M bond ; $\frac{6}{2}$ = 3 (M—M bond)

$Co_4(CO)_{12}$ = TVE

4Co ⇒ 4 × 4 = 36 electron

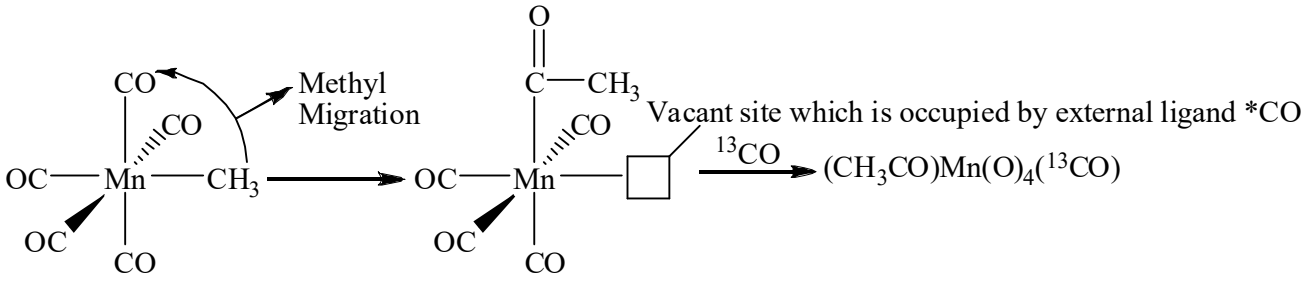
12CO ⇒ 12 × 2 = $\frac{\text{24 electron}}{\text{60 electron}}$

B = n × 18 – TVE = 4 × 18 – 60 = 12 ; $\frac{B}{2} = \frac{12}{2}$ = 6 (M—M bond)

Correct option is (a)

32.

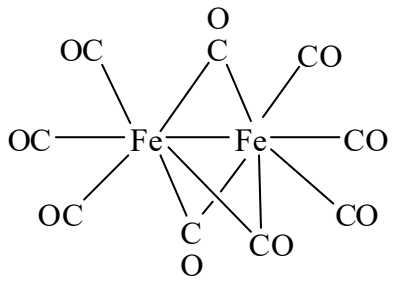
QUANTA CHEMISTRY CLASSES



Correct option is (b)

GATE 2012

18. $Fe_2(CO)_9$



$(\mu_2 - CO)_3\ Fe_2(CO)_6 \Rightarrow$ 6 terminal CO

Correct option is (c)

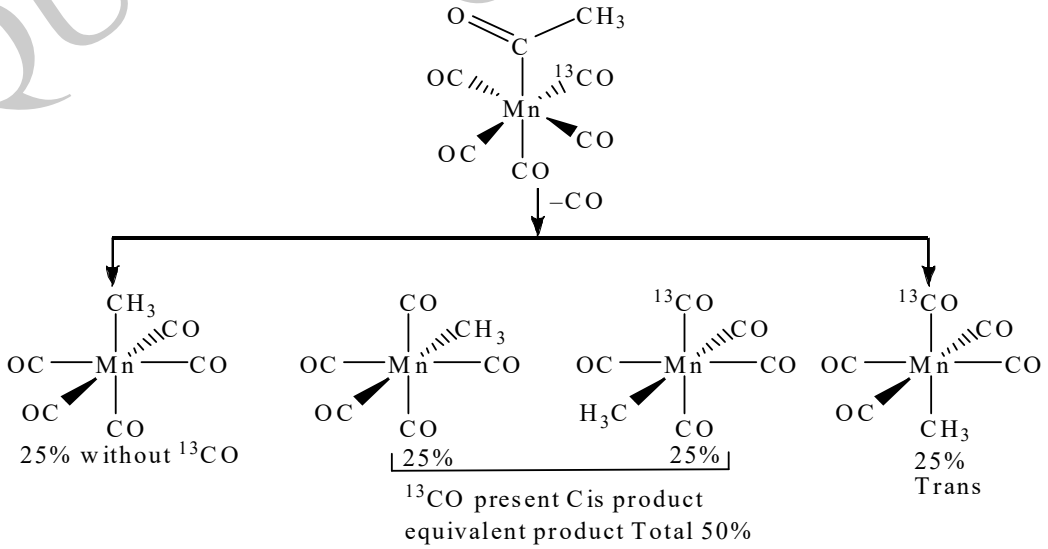
24. Catalytic Cycle of Hydroformylation

$$Co_2(CO)_8 \xrightarrow{H_2} HCo(CO)_4$$

Correct option is (d)

GATE 2013

40.



QUANTA CHEMISTRY CLASSES

Correct option is (b)

41. $Rh_6(CO)_{16}$

TEC $\Rightarrow 6 \times 9 + 16 \times 2 = 86$

Polyhedral electron cont (PEC) $= 86 - 6 \times 12 = 14$

$$\frac{PEC}{2} = \frac{14}{2} = 7 = 6 + 1 \Rightarrow (n+1) \Rightarrow \text{closo.}$$

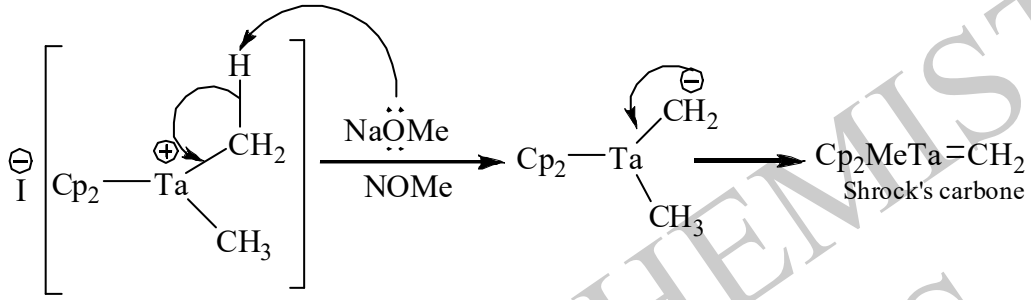
Correct option is (a)

GATE 2014

9. $B_6H_{10} = B6H_6^{-4} \Rightarrow BnH_n^{-4} \Rightarrow$ Nido

Correct option is (b)

15.



Correct option is (c)

40. The ν_{CO} stretching frequency $\propto$ bond strength $\propto$ bond order $\propto \frac{1}{\text{bond length}} \propto$ positive oxidation state.

Correct option is (a)

41. The stability of compound decreases due to presence of β–H. Transition metal possess vaccant vaccant d-orbital which involve in kinetically facile reaction such as β–H elimination.

The driving force for β–Hydrile elimination reaction is the formation of stronger M – H bond than M-alkyl bond.

Correct option is (d)

45. In monsanto acetic and process role of HI is to convert CH_3OH to CH_3I

$CH_3OH + HI \longrightarrow CH_3I + H_2O$

Correct option is (d)

GATE 2015

2. In catalytic cycle of hydrogenation of alkene

- First step involve dissociation of PPh_3 ligand from to creat vacant site
- On descending the group metal – ligand bond dissociation enthalpy increases for transition metal.

Correct option is (a)

50. The ligang PPh_3 is strong σ-donor and weak π-acceptor than CO, hence, it will supply electro density on Cr due to which back donation increases, de Cr–C bond length decreases and C–O bond length increases.

Correct option is (c)

QUANTA CHEMISTRY CLASSES

GATE 2016

1. According to 18 electron count of Neutal atom method ;

Unit	Contribution of electron
M–M bond (Mo–Mo)	2
Bridging haogen (Mo–Cl–Mo)	3
Mo	6
Cp	5

Hence, 2Mo atom $\Rightarrow 2 \times 6 = 12\ e^-$

$4\mu_2$–Cl $\Rightarrow 4 \times 3 = 12\ e^-$

2Cp $\Rightarrow 2 \times 5 = 10\ e^-$

One (Mo–Mo) bond $\Rightarrow 1 \times 2 = 2\ e^-$

$36\ e^-$

Hence, Per Mo $\Rightarrow$ 18 electron

Correct option is (c)

6.

Hetero atom	Replace with
C, Si, Ge, Sn	BH
N, P, As	BH_2
S, Se	BH_3

(a) $B_5H_8^-$ is derived from $B_5H_5^{4-}$, a nido speices

(b) $[C_2B_9H_{11}]^{2-}$ is equivalent to $B_{11}H_{13}^{-2}$, derived from $B_{11}H_{11}^{-4}$, a nido speices

(c) $GeC_2B_9H_{11}$ is equivalent to $B_{12}H_{14}$ is derived from $B_{12}H_{12}^{2-}$, a closo speices

(d) B_6H_{10} is derived from $B_6H_6^{4-}$, a nido speices

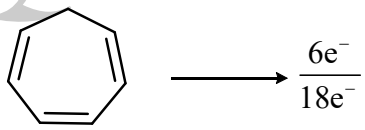
Correct option is (c)

GATE 2017

12. According to Neutral atom method of 18 electron count

$Mo \rightarrow 6e^-$

$3CO \rightarrow 6e^-$



$\longrightarrow \dfrac{6e^-}{18e^-}$

Hence, heptacity is 6

Correct option is (a)

37. $Me_2C_2B_{10}H_{10}$

Methyl lis like hydrogen hece it is 1 electron donoar.

Hence, number of framework electron.

2CH = 6

10BH = 20

QUANTA CHEMISTRY CLASSES

i.e. (n + 1) pair

26 = 13 pair

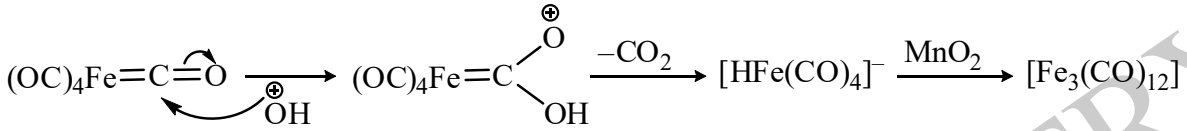
Hence, closo, also de to 12 vertex it has icosahedrum structure.

Correct option is (b)

GATE 2018

25. $[B_5H_8]^- = [B_5H_5]^{4-}$ = Nido

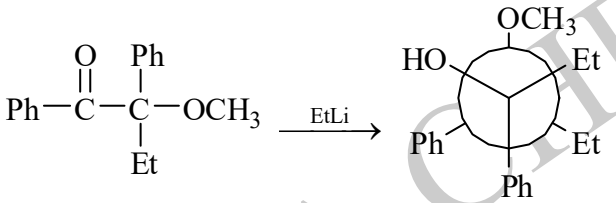
Correct option is (b)

27. 

Correct option is (d)

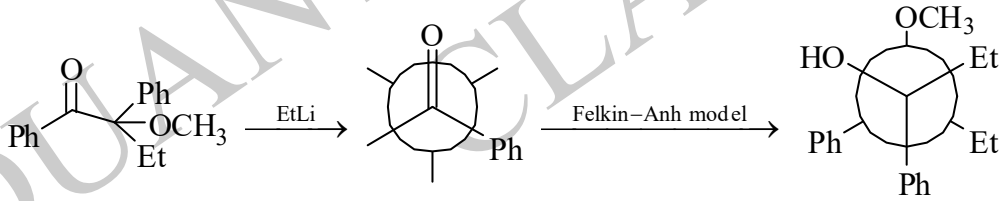
GATE 2019

47. In the following reaction, the stereochemistry of the major product is predicted by the



(a) Cram's model (b) Cram's chelation model

(c) Felkin model (d) Felkin-Anh model

47Sol. 

48. The product obained in the reaction of $Mn_2(CO)_{10}$ with Br_2 is

(a) $Mn(CO)_5Br$ (b) $Mn_2(CO)_8Br_2$ (c) $Mn(CO)_4Br_2$ (d) $Mn_2(CO)_9Br$

48Sol. $Mn_2(CO)_{10} + Br_2 \rightarrow 2Mn(CO)_5Br$

49. The correct molecular representation of $W(Cp)_2(CO)_2$ is

(Cp = cyclopentadienyl)

(a) $[W(\eta^1 - Cp)(\eta^3 - Cp)(CO)_2]$ (b) $[W(\eta^1 - Cp)(\eta^5 - Cp)(CO)_2]$

(c) $[W(\eta^3 - Cp)(\eta^5 - Cp)(CO)_2]$ (d) $[W(\eta^5 - Cp)_2(CO)_2]$

49.Sol. $W(Cp)_2(CO)_2$ It follows $18e^-$ rule.

QUANTA CHEMISTRY CLASSES

$$W(\eta^x Cp)(\eta^y - Cp)(CO)_2$$
$$\downarrow\downarrow \quad \downarrow \quad \downarrow$$
$$TEC \rightarrow 6 + x + y + 2\times 2 = 18$$

$x + y = 18 - 10 = 8$

$x + y = 8$ $x = 3, y = 5$ or $x = 5, y = 3$

Hence $W(\eta^3\text{–}Cp)(\eta^5\text{–}Cp)(CO)_2$ is the correct option.

GATE 2020

50. The CORRECT statement regarding the substitution of coordinated ligands in $Ni(CO)_4$ and $Co(NO)(CO)_3$ is:
(Given: Co–N–O bond is nearly linear; atomic numbers of Co and Ni are 27 and 28, respectively)
(a) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative and dissociative pathways, respectively.
(b) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative pathway.
(c) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative pathway.
(d) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative and associative pathways, respectively.

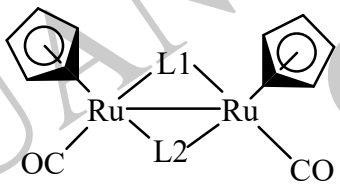
50.Sol.: $Ni(CO)_4$ is $18e^-$ complex.

$Co(NO)(CO)_3$ is also $18e^-$ complex.

Substitution reaction in $18e^-$ complexes undergo by dissociative pathways but in $Co(NO)(C))_3$, NO in linear mode changes into bent mode and $Co(NO)(CO)_3$ Now is $16e^-$ complex because NO give $1e^-$ in bent mode $18e^-$ complex undergo by associative mechanism thats why $Co(NO)(CO)_3$ undergo substitution by associative pathway.

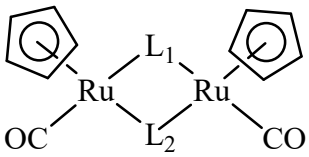
Correct option is (b)

51. The CORRECT combination of L1 and L2 among H^-, NO^-, $MeCH^{2-}$ and CO, that will satisfy the 18 electron rule for both metal centers in the following neutral molecule, is



(Given: atomic number of Ru is 44)
(a) H^-, NO^- (b) H^-, CO (c) $MeCH^{2-}$, CO (d) $MeCH^{2-}$, NO^-

51.Sol.:

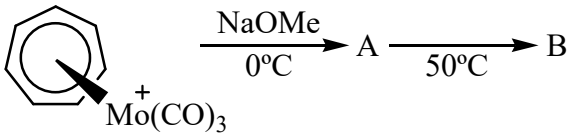


When L_1 and L_2 are $MeCH^{2-}$ and CO respectively then complex follow $18e^-$ rule.

Correct option is (c)

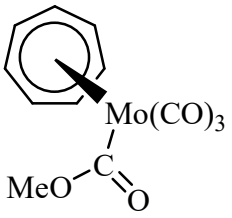
52. In the following reaction sequence,

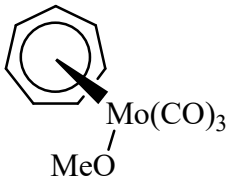
QUANTA CHEMISTRY CLASSES

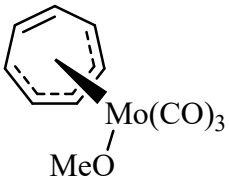


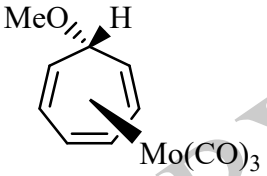
the structure of B is

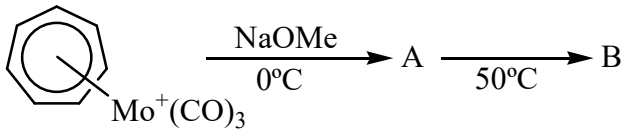
(Given: atomic number of Mo is 42)

(a) 

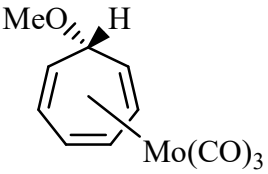
(b) 

(c) 

(d) 

52 Sol.: 

B is thermodynamic product which is stable and follow $18e^-$ rule.



$VEC = 6 + 6 + 2 \times 3 = 18e^-$

Correct option is (d)

53. Among the following,

$[B_{12}H_{12}]^{2-}$, $[Ni_5(CO)_{12}]^{2-}$, $[C_2B_9H_{11}]^{2-}$, $Rh_6(CO)_{16}$, $Os_6(CO)_{20}$, B_5H_{11}, B_6H_{10}

the total number of species having nido structure is _____

(Given: atomic numbers of H, B, C, O, Ni, Rh and Os are 1, 5, 6, 8, 28, 45 and 76 respectively)

53 Sol.: $[B_{12}H_{12}]^{2-} \equiv [B_nH_n]^{2-} \Rightarrow$ Closo

$[C_2B_9H_{11}]^{2-} \equiv [B_{11}H_{13}]^{2-} \equiv [B_{11}H_{11}]^{4-} \rightarrow$ Nido

$[B_5H_{11}] \equiv [B_5H_5]^{6-} \rightarrow$ Arachno

$[B_6H_{10}] \equiv [B_6H_6]^{4-} \rightarrow$ Nido

$OS_6(CO)_{20}$; $TVE = 48 + 40 \Rightarrow 88$ $n + x = \dfrac{VEC - 12n}{2}$ n = No. of metal atom.

$x = -1 \rightarrow$ Supercloso

$x = 0 \rightarrow$ Hypercloso

$x = +1 \rightarrow$ Closo

$x = +2 \rightarrow$ Nido

$x = +3 \rightarrow$ Arachno

QUANTA CHEMISTRY CLASSES

$OS_6(CO)_{20}$, VEC = 88

$$6 + x = \frac{88 - 12 \times 6}{2} = 8$$

$x = 2 \rightarrow$ Nido

$Rh_6(CO)_{16} \Rightarrow VEC = 9 \times 6 + 16 \times 2 = 54 + 32 = 86$

$$6 + x = \frac{86 - 72}{2} = 7$$

$x = +1 \rightarrow$ Closo

$\left[Ni_5(CO)_{12}\right]^{2-} \Rightarrow VEC \rightarrow 50 + 24 + 2 = 76$

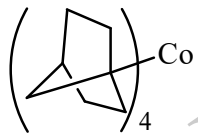
$$5 + x = \frac{76 - 60}{2} = 8$$

$x = 3 \rightarrow$ Arachno

Number of species which are nido is 3.

GATE 2021

54. The geometry and the number of unpaired electrons in tetrakis (1 – norbornyl)Co



respectively, are:

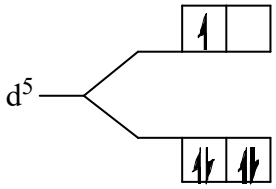
(a) tetrahedral and five (b) square planar and three

(c) tetrahedral and one (d) square planar and one

Ans. c

54.Sol. The 1 – norbornyl ligand is observed to form a stable complex with cobalt through a Co-C bond. It is a bulky & it is less prove to β-hydrogen elimination reaction.

The oxidation state of metal cobalt in the complex is +IV & electronic configuration is d^5. It has been experimentally found that the complex is tetrahedral & it norbornyl induces paining in the system.



no. of unpaired $e^{\Theta} = 1$

Corect option is (c)

55. The metal borides that contain isolated boron atoms are:

(a) Ti_4B_4 and V_3B_4 (b) TiB and HfB (c) Tc_7B_3 and Re_7B_3 (d) Cr_5B_3 and V_3B_2

Ans. c

55.Sol. The structure of metal borides depends upon the M : B ratio. Broides with an isolated boron atom have a low B : M ratio. Tc_7B_3 and Re_7B_3 falls in this category.

Correct option is (c)

56. The Mo–Mo bond order in $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ which obeys the 18-electron rule is _____.

Ans. 3

56.Sol. $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2 = 2\eta^5C_5H_5 = 5 \times 2 = 10e^{\ominus}$

$= 2Mo = 6 \times 2 = 12e^{\ominus}$

$= 4CO = 4 \times 2 = \underline{8e^{\ominus}}$

$TVE = 30\ e^{\ominus}$

Mo of M - M bond $= \dfrac{n \times 18 - TVE}{2}$

$= \dfrac{2 \times 18 - 30e^{\ominus}}{2}$

$= \dfrac{36 - 30}{2}$

$= \dfrac{6}{2}$

So, no. of M-M bond = 3

QUANTA CHEMISTRY CLASSES

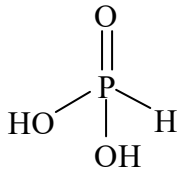
MAIN GROUP ELEMENT

GATE 2005

1. Triplate superphosphate is manufactured in two stage process. First sulphuric acid react with phosphate rock, to produce phossphoric acid. Gypsum is byprouct of the stage and is removed.

Secondary : The phosphoric acid and is reacted with phosphate rock resulting in triplate superphosphate.

Correct option is (d)

2.  Phosphorous acid

Correct option is (b)

3. (a) SiC is known as carborundum

(b) $SiO_2 + 3C \xrightarrow{\Delta} SiC + 2CO$

(c) Pure SiC is almost colourless or pale yellow

(d) Moh's hardness of Carborundum : 9 – 9.5

Diamond : 10

Correct option is (a)

4. CH groups tends to be more positive than BH group as it is 3 electron donor while BH is two electron donor.

Correct option is (b)

GATE 2006

5. $Mg_6Si4O_{10}(OH)_8$ is example of sheet silicates and it commercially known asbestos

Correct option is (a)

6. S^{2-}, Cl^-, K^+, Ca^{2+} are isoelectronic species.

For isoelectronic species,

$$\text{ionic radii} \propto \text{magnitude of negative charge} \propto \frac{1}{\text{Magnitude of } +\text{ve charge}}$$

Correct option is (b)

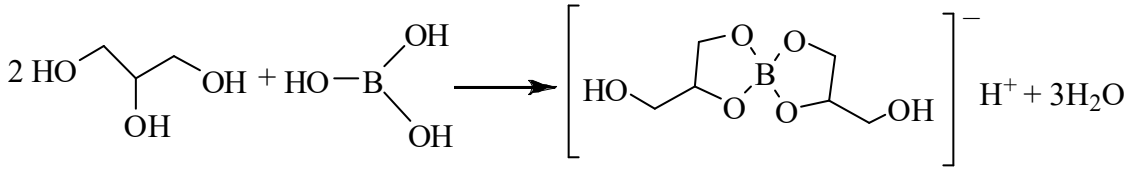
7. $Al_4C_3 + H_2O \rightarrow Al(OH)_3 + CH_4$

$Mg_2C_3 + H_2O \rightarrow Mg(OH)_3 + CH \equiv C - CH_3$

Correct option is (b)

QUANTA CHEMISTRY CLASSES

GATE 2007

8. 

Correct option is (a)

9. $P_4S_{10} \xrightarrow{EtOH} (EtO)_2P(S)SH \xrightarrow{Cl_2} (EtO)_2P(S)Cl \xrightarrow{P-O_2NC_6N_4ONa} \text{Parathion}$

Correct option is (b)

10. Back donation of lone pair $\propto \dfrac{1}{\text{Lewis acidity}}$

Due to small size of fluorine, fluorine has tendency to back donate its lone pair of electron to B. Due to electron donation, electron deficiency of B is reduced. Such tendency to back donation of lone pair decreases as the size of halide increases.

Correct order of lewis acidity is

$BBr_3 > BCl_3 > BF_3$

Correct option is (c)

GATE 2008

11. $Al_4C_3 + H_2O \rightarrow Al(OH)_3 + CH_4$

Correct option is (a)

12. C_{60} is non-polar hence soluble in benezne. Ir reacts with t-butyl lithium and it is made up of 12-five membered and 20 six-membered ring which five-membered rings are surrounded by six-membered ring only.

Correct option is (a)

13. Due to presence of hydrophobic CH_3 group, linear dimethyl polysiloxane $[(CH_3)_2\,SiO]_n$ is hydrophobic in nature.

Correct option is (a)

GATE 2009

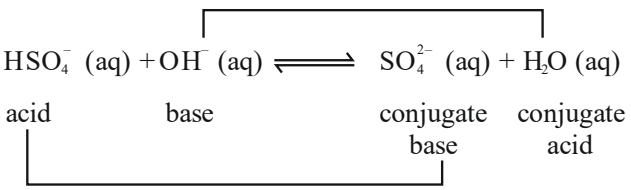
14. $COCl_2 + 4NH_3 \rightarrow CO\,(NH_2)_2 + 4NH_4Cl$

Phosgene

Correct option is (c)

15. In BaF_2 molecule, the coordination number Ba^{2+} is 8 and coordination number fluoride is 4.

Correct option is (b)

16. 

Correct option is (a)

QUANTA CHEMISTRY CLASSES

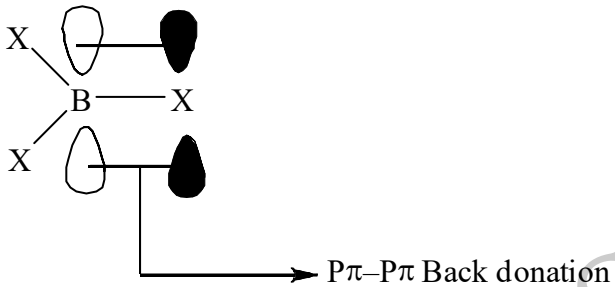
17. $PCl_5 + NH_4Cl \xrightarrow[150°C]{C_6H_5Cl(solvent)} N_3P_3Cl_6$

Correct option is (c)

18. Correct option is (d)

GATE 2010

19. In Boron Halides back donation takes place between boron and halogen This is $P_\pi - P_\pi$.



Back donation which is maximum in B–F it is $2p_\pi - 2p_\pi$ while in B–Cl it is 2p–3p hence weaker in B–Cl. Therefore, electron deficienc of boron is compensated by 'F' more as compare to 'Cl'. Henc BF_3 is weaker lewis acid than BCl_3.

Correct option is (b)

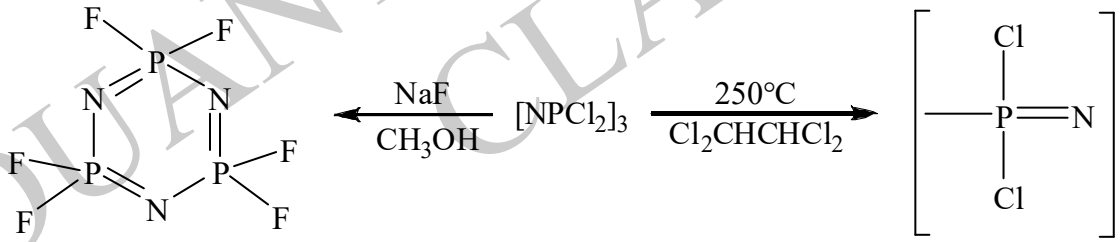
20. Single chain silicate are called pyrxenes and are formed by sharing of oxygen atoms on two comrs of each tetrahedron. They have general formula of $(SiO_3)_n^{2n-}$ if n = 1 1 $[SiO_3]^{2-}$

Correct option is (b)

21. As we move downward in group the inertness of ns^2 electron pair increases (called inert pair effect). This IPE will be maximum in last element of group. Hence $BiCl_5$ is least stable.

Correct option is (b)

22.

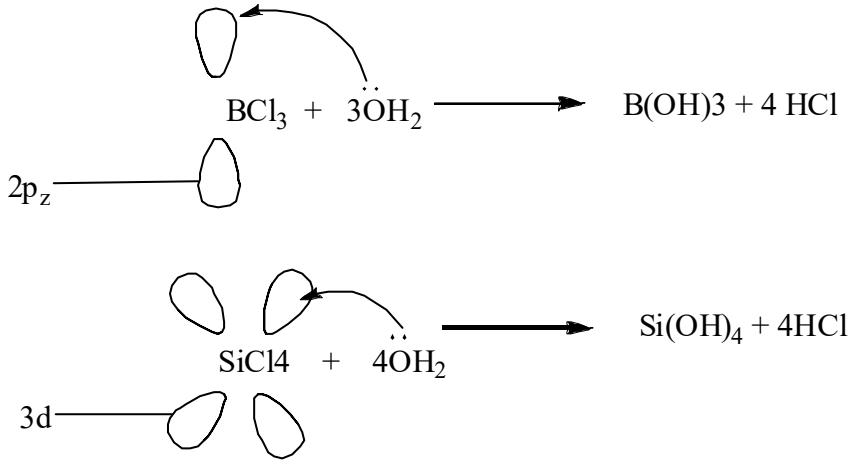


Correct option is (b)

GATE 2011

23. Out of these compounds BCl_3, $SiCl_4$ have wacant orbitals, hence H_2O can attack to them easily and they show rapid hydrolysis.

QUANTA CHEMISTRY CLASSES



SF_6 is spherical with stronger S–F bonds as well as steric hinderance hence it is not hydrolysed. PCl_5 also vacant orbitals and hence can show hydrolysis.

$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$ (partial hydrolysis)

$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$ (complete hydrolysis)

$SiMe_4$ has steric repulsion hence H_2O can't attack, showing no hydrolysis. Hence BCl_3, $SiCl_4$, PCl_5 show more rate of hydrolysis.

Correct option is (c)

24. $XeF_2 + AsF_5 \rightarrow [XeF]^+ + [AsF_6]^-$

Correct option is (a)

25. Correct option is (d)

26. $2Na_2HPO_4 + 3\ NaH_2PO_4 \longrightarrow \underset{\text{Sodium pentaphosphate}}{Na_7P_5O_{16}} + 4H_2O$

Correct option is (d)

27. $Na_7P_5O_{16} \longrightarrow 7Na^+ + P_5O_{16}^{7-}$

Correct option is (c)

GATE 2012

28. Hydration energy of a metal cation increases with increases in effective nuclear charge hence, hydration energy ioncreases regularly from Ca^{2+} to Zn^{2+}.

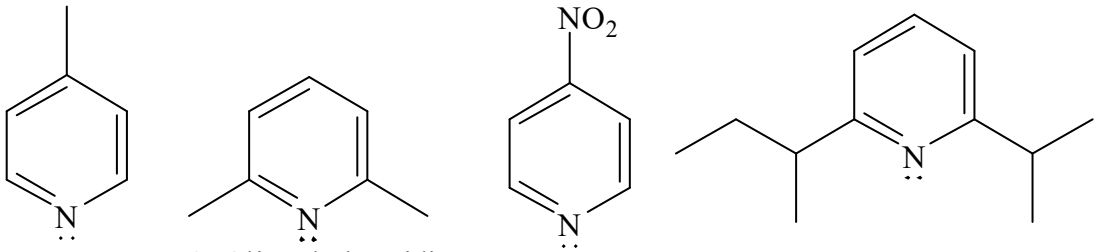
$$\xrightarrow[\text{increasing order of hidration energy}]{Ca^{2+} < Mn^{2+} < Zn^{2+}}$$

Correct option is (d)

29. $CH_3SiCl_3 \xrightarrow{H_2O} H_3C-Si(OH)_2-OH$ Form cross linked silicon polymer

Correct option is (b)

30.

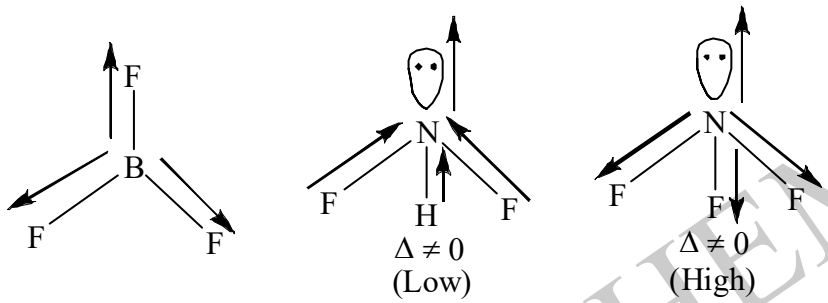


4-methyl pridine 2, 6dimethyl pyridine 4-nitropyridine 2, 6dimethyl tertbutyl pyridine

Lewis basicity $\propto$ electron-density $\propto \frac{1}{\text{sterice repulsion}} \Rightarrow B(CH)_3$ is Lewis acid

Correct option is (a)

31.



Correct option is (b)

32. $K_2Cr_2O_7 + 4NaCl + 6H_2O_4 \rightarrow 2CrO_2Cl_2 + 2KHSO_4 + 4NaHSO_4 + 3H_2O$

$CrO_2Cl_2 + 2NaOH \longrightarrow Na_2CrO_4 + HCl$

Yellow solution

$Na_2Cr_4 + 2AgNO3 \longrightarrow Ag_2CrO_4 + NaNO_3$

Correct option is (d)

GATE 2013

33.

In NaCl	CuCl
Na^+	Cu^+
(2, 8)	(2, 8, 18) ⟵ it is pseunoble gas ion. Hence will have more polarising power due to which CuCl has more co-valent character and hence less melting point than NaCl

In NaF and NaCl, 'Cl^-' is of bigger size than F^- hence Cl^- will be easily polarisable than F^-. Due to this NaCl will

QUANTA CHEMISTRY CLASSES

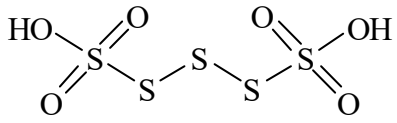
have more polarisation, more co-valent character (Fajan rule) and lower melting point.

Therefore, overall order of melting point will be

$CuCl < NaCl < NaF$

Correct option is (a)

GATE 2014

34. 

Correct option is (4)

35. $BCl_3 + NH_4Cl \xrightarrow{140°C} \underset{(X)}{B_3N_3H_3Cl_3} \xrightarrow{NaBH_4} \underset{(Y)}{B_3N_3H_6}$

Correct option is (a)

GATE 2015

36. BF_3, BCl_3, BBr_3 ↓ Back donation decreases Hence Boron 'p' orbital have less electron density, hence more acidity. Due to which ease of added formation also increases

$BBr_3 > BCl_3 > BF_3$

Correct option is (c)

37. $S_2Cl_2 + NH_3 \rightarrow N_4S_4 + NH_4C + S_8$

Correct option is (d)

GATE 2016

38. $P_2O_5 + 2HNO_3 \rightarrow 2HPO_3 + N_2O_5$

$HCLO_4(\ell) + P_2O_5(s) \rightarrow Cl_2O_7(\ell) + 2HPO_3(s)$

Correct option is (d)

39. $2N_3^- + I_3^- \longrightarrow \underset{\text{Bricks effervescence}}{3N_2 + I_2 + I^-}$

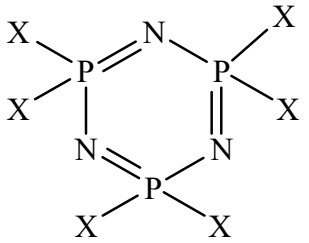
$Fe^{3+} + 3CNS^- \longrightarrow \underset{(\text{red colour})}{Fe(SCN)_3}$

$4Fe^{3+} + 3Fe^{2+} + 18CN^- \longrightarrow \underset{(\text{blue colour})}{Fe_4\left[Fe(CN)_6\right]_3}$

Correct option is (b)

QUANTA CHEMISTRY CLASSES

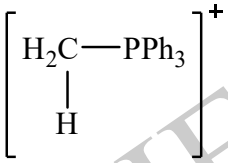
GATE 2017

40. 

As the electronegativity of substitent increases. Energy of d-orbit decreases hence better interaction between 2p-orbita of nitrogen and 3d-orbital of phosphorus. Hence, stroge the π-bond.

Correct option is (a)

GATE 2018

41. $PCl_3 + 3Phi \longrightarrow 3LiCl + PPh_3 \xrightarrow{CH_3I}$  (Y) $\xrightarrow{n-BuLi}$ $H_2C{=}PPh_3$ (Z)

Correct option is (c)

GATE 2019

42. SOL.

43.Sol. Option A is incorrect as Si–C bond is thermally stable

44.SOl

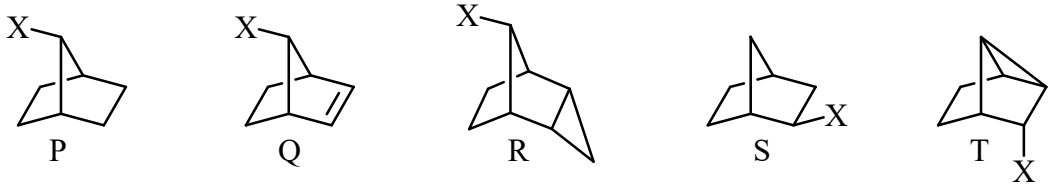
GATE 2020

45.Sol.: Boron nitride is reactive towards fluorine.

$$2BN + 3F_2 \rightarrow 2BF_3 + N_2$$

Correct option is (c)

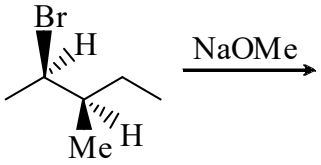
46.Sol.: Rate of solvolysis is:



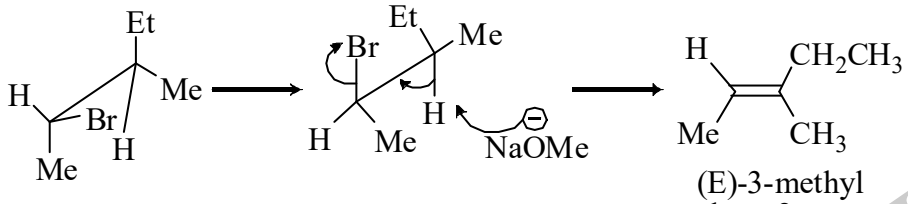
So, rate of solvolysis is T > R > Q > S > P

GATE 2021

47.Sol.



(2R, 3R) – 2 bromo – 3 – methyl pentane



(E)-3-methyl bent-2-ene

(d) is correct option

48.Sol. Lewis acidity $\propto \frac{1}{\text{back bonding}}$

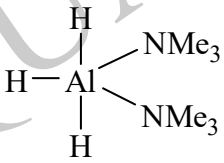
Extent of backbonding : F > Cl > Br

More the number of F atoms attached to B, higher will be the backbonding and lower will be the lewis acidity.

$BFBr_2 > BFClBr > BF_2Br > BF_2Cl$

Correct option is (a)

49Sol. $LiAlH_4 + Me_3N.HCl \longrightarrow \underset{\text{(tetrahedral)}}{AlH_3(NMe_3)} \xrightarrow{NMe_3.HCl} \underset{(sp^3d^2)}{AlH_3(NMe_3)_2}$



$\Rightarrow$ trigonal bipyramidal

Correct option is (b)

QUANTA CHEMISTRY CLASSES

LANTHANIDE AND ACTINIDE

GATE 2005

1. $[Ce(NO_3)_6]^{2-}$ has icosahedral structure. Other given complexes has eight coordination number and thus have square antiprismatic structure.

   Correct option is (a)

GATE 2006

2. Reaction between Pr_6O_{11} and dil HCl leads to formation of Pr(III) O_2 and Cl_2 gas. Solution Pr(III) is coloured.

   Correct option is (a)

GATE 2007

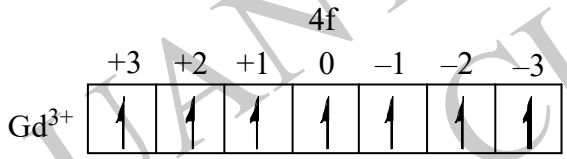
3. In lanhanoids, as the atomic number increases, size of lanthanide ion (CO^{3+}) decreases. O-hydroxylsobutyrate ion forms a stable complex with smaller ion. The correct order of trivalent lanthanide ion is separation by

   $Lu^{3+} > Yb^{3+} > Dy^{3+} > Eu^{3+}$

   Correct option is (a)

GATE 2013

4. Electronic configuration of Gd^{3+} = 4f[Xe]



   L = 0, S = 7/2

   Number of unpaired electron (n) = 7

   $\therefore \quad \mu_{spin\ only} = \sqrt{n(n+2)} = \sqrt{7(7+2)} = 7.9$ BM

   Correct option is (a)

GATE 2016

5. The calculated magnetic moments for lantanides have good agreement with observed values. For more lanthanoids the value of λ is about 1000 cm^{-1}. However, λ value for Eu^{3+} is about 100 cm^{-1}. Which is small value. Therefore, the agreement for Eu^{3+} is not very good the complexes with speed value of λ have significant spin and orbital contributions.

   Correct option is (c)

GATE 2017

6. If the electromagnetic radiations observed by a compond lie in UV-visible region then compond appears coloured

La^{3+} $(4t^0)$ colourless

Eu^{3+} $(4t^6)$ pale pink colour

Gd^{3+} $(4t^7)$ colourless

Lu^{3+} $(4t^{14})$ colourless

Correct option is (b)

GATE 2018

7. Due to larger size of anthanoid they have coordinator number generally greater than 6. Also due to deep buried mature of f-orbital they show sharp peak in their absorption spectrum.

Correct option is (a)

GATE 2020

8.Sol.: In uranium recovery process an aqueous solution of uranyl ion is evaporated dried in air at 400ºC and subsequently reduced with hydrogen at 200ºC to obtained uranium compound with oxidation state of +4 i.e. VO_2

$x - 4 = 0$

$x = +4$

9Sol.: Difference in magnetic moment of Eu^{3+} is due to population of electrons at higher J level via thermal excitation.

GATE 2021

10.**Sol.** All the actinide elements are radioactive, in the actinoids last electron goes into the 5f orbitals due to its large size and diffused nature it has very poor shielding effect. electrons in 5f orbitals are less tightly bound also it much further than the nucleus compound to 4f orbitals.

The trans uranium compounds are the element with are atomic number greater than 92.

The ionic radii decrease from thorium to lawrencium which is called actinide contraction

Correct option is (a), (b) and (c)

QUANTA CHEMISTRY CLASSES

NUCLEAR

GATE 2016

1. Lead (Pb) has four stable isotopes :

^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{204}Pb is entering a primordial nuclide and is not a radiogenic nucldie

Correct option is (a)

GATE 2017

2. $^{210}Bi \xrightarrow{\beta-decay} (X)$

$t = 0 \qquad [A]_0$

$t = 15$ days, $[A] = \frac{1}{8}[A]_0$

$t = ?$ days, $[A] = \frac{1}{4}[A]_0$

$$\boxed{\lambda = \frac{2.303}{t}\log\frac{[A]_0}{[A]} \rightarrow \text{for 1st order kinetics}}$$

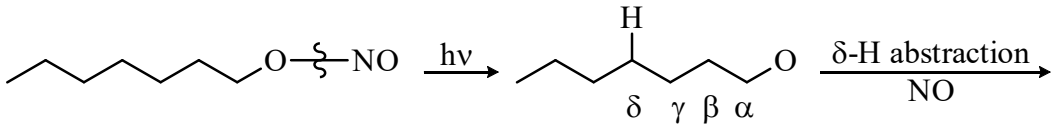
$$\Rightarrow \lambda = \frac{2.303}{15}\log\frac{[A]_0}{18[A]_0} = \frac{2.303}{15} \times \log 2^3 = \frac{2.303\times 3\times 0.3010}{15}$$

$$\Rightarrow \lambda = 0.1386$$

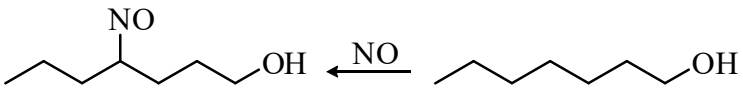
$$t = \frac{2.303}{0.1386}\log\frac{[A]_0}{1/4[A]_0} = \frac{2.303}{0.1386} \times 2/0.3010$$

$$\boxed{t = 10.0029 \text{ days}}$$

Correct answer is (10.0029)



3.



Correct option is (b)

QUANTA CHEMISTRY CLASSES

GATE 2019

4.Sol. $^{238}_{92}U \rightarrow {}^{210}_{82}Pb + x\ {}^{4}_{2}\alpha + y\ {}^{0}_{-1}\beta$

Equating mass No.

$238 = 210 + 4x + 0\ (y)$

$x = 7$

Equating Atomic No.

$92 = 82 + 2x - y$

$y = 4$

$\Rightarrow \quad x + y = 7 + 4 = 11$

GATE 2020

5.Sol.: $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U$ →

$^{99}_{41}Nb \rightarrow {}^{99}_{41}Nb \rightarrow X_1 \rightarrow X_2 \rightarrow X_3$

$^{133}_{51}Sb \rightarrow {}^{133}_{51}Sb \rightarrow Y_1 \rightarrow Y_2 \rightarrow Y_3 \rightarrow Y_4$

$^{99}_{41}Nb \rightarrow {}^{99}_{42}Mo \rightarrow {}^{99}_{43}Tc \rightarrow {}^{99}_{44}Ru$

$^{133}_{51}Sb \rightarrow {}^{133}_{52}Te \rightarrow {}^{133}_{53}I \rightarrow {}^{133}_{54}Xe \rightarrow {}^{133}_{55}Cs$

Correct option is (b)

GATE 2021

6.Sol. The radioactive reaction are first order reaction

So $\left(\frac{A}{A_o}\right) = \left(\frac{1}{2}\right)^{t/t_{1/2}}$

Substituting the value

$$\left(\frac{x}{1\,mg}\right) = \left(\frac{1}{2}\right)^{\frac{1}{5.27}}$$

$x = 0.876$ mg

Amount disintegrated = $(1 - 0.876)$ mg

$= 0.123$ mg

QUANTA CHEMISTRY CLASSES

BIOINORGANIC

GATE 2005

1. The metal present at the active site of the protein carboxypeptidase A is zinc

   Correct option is (a)

2. Cytochrome-C → Iron

   Colmodulin → Calcium

   Chlorophyll → Mangnesium

   Alcohol dehydrogenase → Zinc

   Correct option is (d)

GATE 2006

3. Iron sulphur cluster in biological systems are involved in electron transfer reaction.

   Correct option is (d)

4. Carboxylate for Ca^{2+} and imidazole for Cu^{2+}.

   Correct option is (c)

5. When a reduced cytochrome transfers and electron from its Fe(II) to the bound O_2, a metal bound superoxide is formed and ν_{O_2} decreases. Because bond order of O_2 is 2 and O_2^- is 1.5.

   Correct option is (b)

6. In biological systems, the Cu involved in the dioxygen transport besides Fe

   Correct option is (d)

GATE 2008

7. In biological systems, Cu^{2+} and Fe^{2+} metal ion involve in electron trnasport. This is due their variable oxidation state.

   Correct option is (d)

GATE 2010

8. Fe act as electron transfer agent in many reaction. Zn act as catalyst in hydrolysis reaction specially enzymatic reaction by carboxypeptidase.

   Correct option is (a)

QUANTA CHEMISTRY CLASSES

GATE 2011

9. Vitamin B_{12} co-enzyme is naturally occuring organometallic compound.

Correct option is (a)

10. Red colour of oxyhemoglobin is mainly due to $\pi - \pi^*$ transition in prophyrin system

Correct option is (d)

GATE 2014

11. In photosynthesis, Mg^{2+} present in chlorophyll. It has small spin-orbit coupling. So, inter system crossing is inhibited which favours the energy transfer from the excited singlet state.

Correct option is (b)

GATE 2015

12. The O_2 bidning efficiency of haemoglobin is maximum at blood pH is 7.4.

Correct option is (d)

13. Hemocyanin is a copper containing protein which is responsible for oxygen transport insome invertibrates.

Correct option is (b)

GATE 2016

14. During oxygen transpot by hemerythrin, oxygen is bound as HO_2^- to one Fe(III) only

Correct option is (b)

15. At low pH and low pressure Hb has less oxygen binding tendency. Whie for Mb this is not Δ_0.

Correct option is (c)

16. Correct option is (c)

GATE 2017

17. In oxy haemoglobin Fe is in +3 oxidation state and O_2 is in O_2^{-1}

$O_2 \approx \nu_{O-O} = 1560\ cm^{-1}$; $O_2^- \approx \nu_{O-O} = 1100\ cm^{-1}$; $O_2^{2-} \approx \nu_{O-O} = 750\ cm^{-1}$

As oxygen accept electron in π^* orbital hence, bond order get reduced and frequecy decreases.

Since after binding to Fe in Hb bond between O–O necp,e wealer comparison to free O–O bond in O_2

There fore force constant k decreases and $\nu \propto \sqrt{k}$ stretching frequency would decrease

Correct option is (a)

18. Chlorophylls are complexes of Mg^{2+} with porphyrin ring in which one of the pyrrole rings has been reduced. A perphine ring with one double bond reduced is called a cjhlorin. Therefore, chlorophyls are the complexes of Mg^{2+} metal ion with subtituted chlorin (maarcocylic skeletion)

Correct option is (a)

QUANTA CHEMISTRY CLASSES

GATE 2018

19. Both oxidised and reduced fom of plastocyanin have distorted Td geometry.
Correct option is (d)

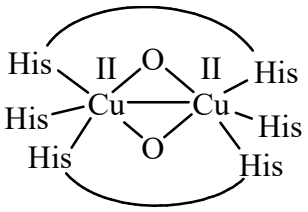
20. O_2 coordinated to oxyhemoglobin exist as O_2^- while in oxyhemocyanin as O_2^{2-}
Correct option is (a)

GATE 2019

21Sol. (P) Ferritin → (III) Metal storage
(Q) Rubredoxin → (I) Electron transfer
(R) Cobalamine → (IV) Methyl transfer
(S) Carbonic anhydrase → (II) Acid-Base catalysis
Correct answer is (b)

GATE 2020

22.Sol.:



Coordination number = 5

Mode of oxygen binding $= \mu - \eta^2 : \eta^2 - O_2^{2-}$

Blue colour due to LMCT.

d^9, unpaired electron of 1 Cu couples with 2nd Cu atom.

So diamagnetic due to antiferro.

Magnetic coupling.

Correct option is (c)

23.Sol.: Metalloenzyme Reaction

Cytochrome p-450; $R - H + O_2 + 2H^+ + 2e^- \rightarrow R - OH + H_2O$

Coenzyme B_{12}; $H_2N-CH_2-COOH \longrightarrow H_2N-\underset{\displaystyle H_2C-OH}{\underset{|}{CH}}-COOH$

Catalase; $2H_2O_2 \rightarrow 2H_2O + O_2$

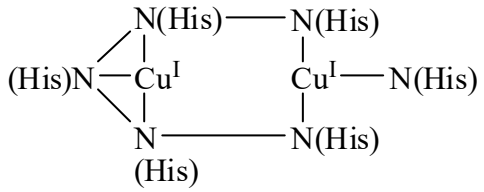
Cytochrome coxidase $\rightarrow O_2 + 4e^- + 8H^+ \rightarrow 2H_2O + 4H^+$

Correct option is (c)

QUANTA CHEMISTRY CLASSES

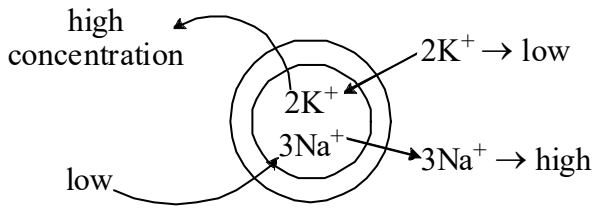
GATE 2021

24.**Sol**. Hemocyanin is a non-heme protein because it has neither heme group nor the cyanide ion present.



Correct option is (c)

25.**Sol**. Sodium potassium pump work againt the concentration gradient. Ions are transported from low centration to high.



Overall $\underset{(\text{inside})}{3Na^+} + \underset{(\text{outside})}{2K^+} + ATP + H_2O \rightarrow \underset{(\text{out})}{3K^+} + 2K^+(\text{inside}) + ADP + Pi$

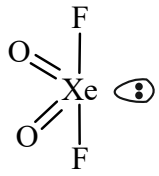
Correct option are (b) and (d)

QUANTA CHEMISTRY CLASSES

CHEMICAL BONDING

GATE 2005

1.



Distorted Td

Correct option is (a)

2. $O_2^- \Rightarrow$ 1.5 Paramagnetic.

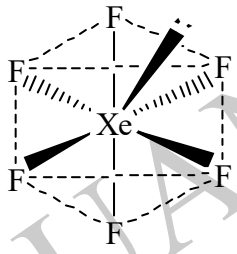
$O_2 \Rightarrow$ 2.0 Paramagnetic

$O_2^+ \Rightarrow$ 2.5 Paramagnetic

$O_2^{2-} \Rightarrow$ 1.0 Diamagnetic

Correct option is (d)

GATE 2006

3. 

distorted octahedral

Correct option is (b)

GATE 2007

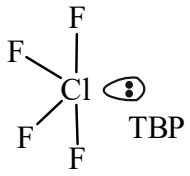
4. $[Co(NH_3)_6]^{3+}$ and $[Co(H_2O)_6]^{3+}$ both are low spin complexes. They involve inner 3d orbital in hybridization. Hence, they have same hybridization i.e., d^2sp^3

Correct option is (d)

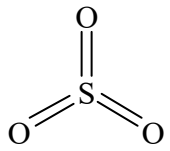
QUANTA CHEMISTRY CLASSES

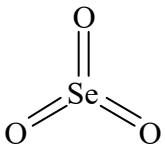
GATE 2009

5.



Correct option is (d)

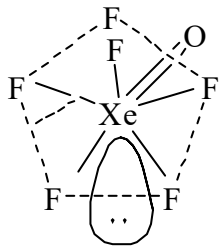
6. 



Planar

Correct option is (b)

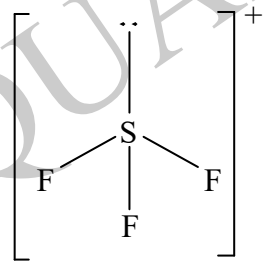
GATE 2010

7. 

Correct option is (d)

GATE 2011

8. The Hybridised sp^3 in $[SF_2Cl]^+$.

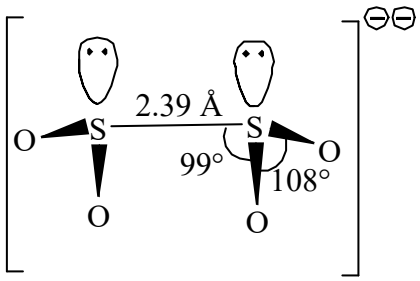


hence, the shape will by trigonal pyramidal.

In $S2O_4^{--}$ (Dithionite ion) 's' is sp^3 hybridised by the S–S bond length are longer than that in polysulphites hence lp–lp repulsion is minimum.

Due to this here SO_2 planes almost parallel (dihedral angle is 30°) giving if (especially (SO_2^-) unit) a planar eclipsed structure.

QUANTA CHEMISTRY CLASSES

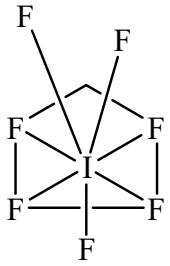


Correct option is (a)

GATE 2015

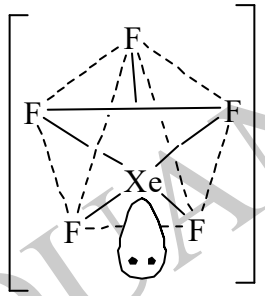
9. Due to 2pπ-3dπ interaction in $N(SiH_3)_3$ it has a planar geometry.

Correct option is (d)

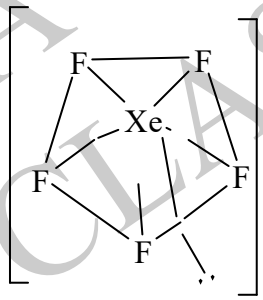
10.  D_{5h} point group

Correct option is (b)

GATE 2016

11. 

Square pyramidal



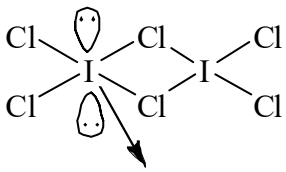
Pentagonal planar

Correct option is (d)

GATE 2019

12.Sol. In solid form ICl_3 exist as dimer

I_2Cl_6



hyb = sp^3d^2

QUANTA CHEMISTRY CLASSES

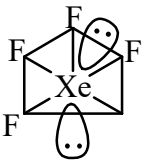
GATE 2020

13.Sol.: XeF_5^-

$$\text{Stearic number} = \frac{1}{2}\left[\text{V.E} + \text{Monovalent} + \text{Charge atom}\right]$$

$$= \frac{1}{2}\left[8 + 5 + 1\right] = 7$$

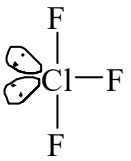
5 bond pair + 2 lone pair.

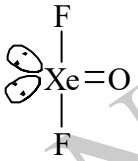


Shape is pentagonal planar.

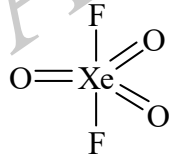
Correct option is (d)

GATE 2021

14.Sol. $ClF_3 \Rightarrow$  $\Rightarrow$ T-shape

$XeOF_2 \Rightarrow$  $\Rightarrow$ T-shape

$N_3^- \Rightarrow [N \leftarrow N \equiv N]^- \Rightarrow$ Linear

$XeO_3F_2 \Rightarrow$  $\Rightarrow$ Trigonal bipyramidal

Correct option is (c)

QUANTA CHEMISTRY CLASSES

ANALYTICAL

GATE 2014

1. The atomic absorption spectroscopy, the atomization process utilizes flame
Correct option is (a)

GATE 2019

2.Sol. Sample weight = 25 mg No. of moles = $\frac{25\times10^{-3}}{250} = 10^{-4}$

After dehydration = 16 mg

Amount of H_2O = 25 – 16 = 9 mg

Moles of $H_2O = \frac{9\times10^{-3}\,g}{18} = 0.5\times10^{-3} = 5\times10^{-4}$ moles

No. of moles lost per molecule is 5.

GATE 2021

3. Sol. Molar mass of $[Co_3(AsO_4)_2\cdot H_2O]$ is

= 3 × 59 + (75 + 16 × 4) × 2 + 2 × 1 + 16 × 1 = 473 g

473 g of $[Co_3(AsO_4)_2\cdot H_2O]$ contains, 177 g of Co

1g Co required $\frac{433}{117\,g}$ of $[Co_3(AsO_4)_2\cdot H_2O]$

1 kg (100 g) cobalt required $\frac{433}{117}\times100\,g$ of $[Co_3(AsO_4)_2\cdot H_2O]$

= 2672.31 g

= 2.672 kg

QUANTA CHEMISTRY CLASSES

INSTRUMENTAL METHOD (INORGANIC SPECTRA)

GATE 2006

1. ^{14}N (I = 1)

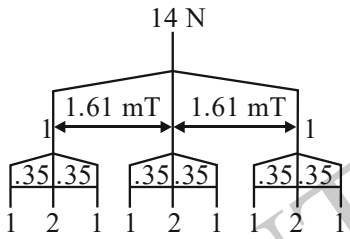
Radical multiplicity $\rightarrow$ (2NI + 1)

$(2 \times 1 \times 1 + 1)$

$\rightarrow$ 3 triplet

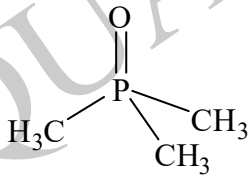
2 protons $\left[I = \frac{1}{2}\right]$

Multiplicity = (2NI + 1) = $\left(2 \times 2 \times \frac{1}{2} + 1\right)$ = 3 triplet



Number of fine = 9

Correct option is (d)

2. 

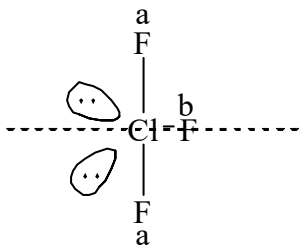
In ^{13}C NMR number of line due to ^{31}P = (2NI + 1) = $\left(2 \times 1 \times \frac{1}{2} + 1\right)$ = 2 line

In ^{13}P NMR $\rightarrow$ One line singlet (No splitting with ^{13}C)

QUANTA CHEMISTRY CLASSES

GATE 2008

3.

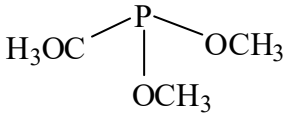


^2F_a splits into a doublet with ^1F_b

^1F_b splits into a triplet with ^2F_b

$$^2F_a \longrightarrow (2\,NI + 1) \Rightarrow \left(2\times1\times\frac{1}{2}+1\right) = 2 \text{ doublet}$$

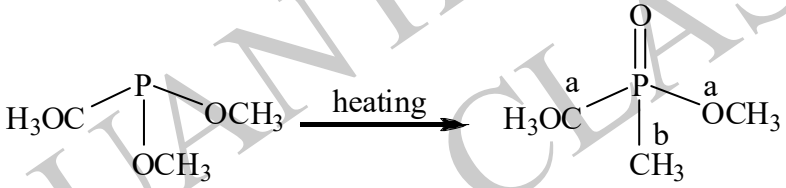
$$^1F_a \longrightarrow \left(2\times2\times\frac{1}{2}+1\right) = 3 \text{ triplet}$$

4. $PCl_3 + CH_3OH \longrightarrow$ 

m/z = 124

$$\text{In } ^1\text{HNMR} = [2\,NI_p + 1] = \left[2\times1\frac{1}{2}+1\right] = 2 \text{ doublet}$$

Correct option is (a)

5. 

^{1}HNMR = $[2NI_p + 1]$

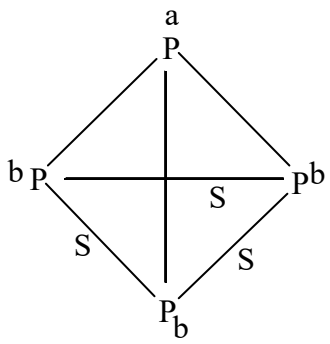
$$\text{For, a} = \left[2\times1\times\frac{1}{2}+1\right] = 2 \text{ doublet and For, b} = \left[2\times1\times\frac{1}{2}+1\right] = 2 \text{ doublet}$$

Correct option is (b)

QUANTA CHEMISTRY CLASSES

GATE 2009

6. P_4S_3



^{31}P NMR $= \left(2NI_{P_a}+1\right)\left(2NI_{P_b}+1\right)$

$= \left(2\times1\times\frac{1}{2}+1\right)\left(2\times3\times\frac{1}{2}+1\right)$

$=$ 2 (↓) Doublet, 4 (↓) Doublet

Correct option is (c)

7. HD $\longrightarrow$ ^1H NMR

Multiplicity = (2NI + 1) = (2 × 1 × 1 + 1) = 3 triplet

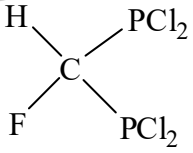
1 : 1 : 1

Correct option is (c)

GATE 2011

8. The correct pair ^1H and ^{31}P NMR

$C(H)(F)(PCl_2)_2$



^1H NMR $\rightarrow$ (2NI + 1) $(2NI_P + 1)$

$\rightarrow \left(2\times1\times\frac{1}{2}+1\right)\left(2\times2\times\frac{1}{2}+1\right)$

$\rightarrow$ (2) (↓) Doublet, (3) (↓) Triplet

31P NMR $\rightarrow$ $(2NI_F + 1)(2NI_H + 1)$

QUANTA CHEMISTRY CLASSES

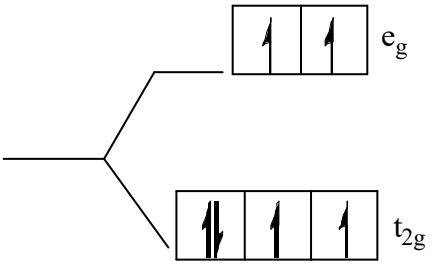
$$\rightarrow \left(2+\frac{1}{2}\times 1+1\right)\left(2\times 1\times \frac{1}{2}+1\right)$$

$$\rightarrow \underset{\text{Doublet}}{\overset{2}{\downarrow}} \qquad \underset{\text{Doublet}}{\overset{2}{\downarrow}}$$

Correct option is (c)

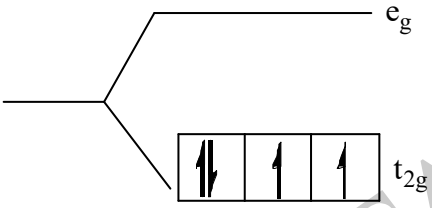
GATE 2012

9. (1) $FeCl_2 \cdot 4H_2O \rightarrow Fe^{2+}$ [H.S.] $\rightarrow 3d^6\ 4s^0$



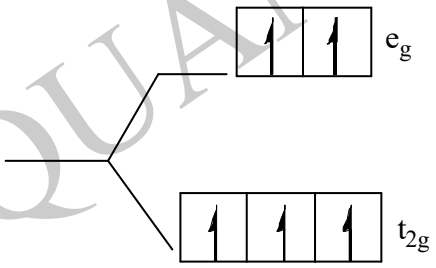
Electronic axial ligand t_{2g} – unsymmetrical

(2) $K_2[Fe(CN)_5 NO] \rightarrow Fe^{2+}$ (LS)



Ligand unsymmetry axial electroic spherical

(3) $FaCl_3 \cdot 6H_2O \rightarrow Fe^{+3}$ (HS)



Electronic -spherical ligand spherical

$FeCl_2 \cdot 4H_2O > K_2[Fe(CN)_5 NO] > FeCl_3 \cdot 6H_2O$

Correct option is (a)

QUANTA CHEMISTRY CLASSES

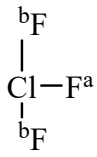
GATE 2015

10. The "g" value of diphenylpicrylhydrazyl (DPPH) is 2.0036 and ESR spectrum of DPPH in solid state gives one line.

Correct option is (a)

GATE 2016

11.



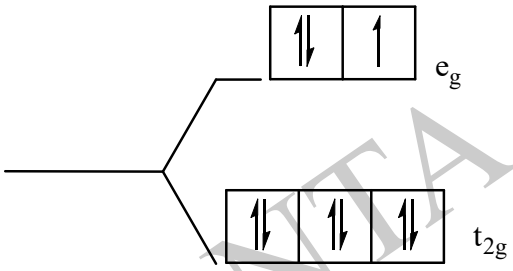
$^{a}F = (2NI_{Fa} + 1) = \left(2\times1+\frac{1}{2}+1\right) = 2$ (doublet); $^{b}F = (2NI_{Fb} + 1) = \left(2\times2+\frac{1}{2}+1\right) = 3$ (triplet)

Correct option is (c)

GATE 2017

12. In $CuSO_4, 5H_2O$

Electronic configuration = $3d^9\ 4s^0$



Last electron in d_{x^2} orbital. So, $g > g_1$

Correct option is (a)

GATE 2019

13.Sol. CH_3

3 equivalent proton coupling with radical.

(n + 1) = (3 + 1) = 4 peaks with intensity according to pascal triangle.

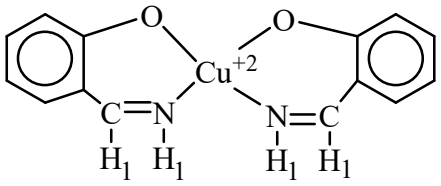
Intensity $\Rightarrow$ 1 : 3 : 3 : 1

Correct answer is (d)

QUANTA CHEMISTRY CLASSES

GATE 2020

14 Sol.: Total number of g_{11} lines expected in the EPR spectrum of solution having pure ^{63}Cu and ^{14}N at 77 K.



Cu = I = 3/2

Observation of spectral line linear $= \left(2\times 1\frac{3}{2}+1\right)(2\times 2\times 1\times 1)(2\times 1)(2+1)$

$= 4 \times 5 \times 3 = 60$ lines.

Correct option is 60 lines

QUANTA CHEMISTRY CLASSES

PERODIC

GATE 2019

1.**Sol.** $d = 3Å$ $\mu_{obs} = 10.8$ D.

$d = 3 \times 10^{-8}$ cm

$\mu_{cal} = a \times d$ (1 unit charge $= 4.8 \times 10^{-10}$)

$= 4.8 \times 10^{-10}$ esu $\times 10^{-8} \times 3$ cm

$= 14.4 \times 10^{-18}$ esu cm

$\mu_{cal} = 14.4$ D

$$\% \text{ I.C.} = \frac{\mu_{obs}}{\mu_{cal}} \times 100 = \frac{10.8}{14.4} \times 100 = 75\%$$

GATE 2021

2. $\oplus$ and $\odot$ are two operators on number p and q such that

$$p \oplus q = \frac{p^2 + q^2}{pq} \text{ and } p \odot q = \frac{p^2}{q};$$

If $x \oplus y = 2 \odot 2$, then $x =$

(a) $\frac{y}{2}$ (b) $\frac{3y}{2}$ (c) y (d) $2y$

QUANTA CHEMISTRY CLASSES